# THE SCIENTIFIC BASIS FOR UNDERSTANDING THE OFF-TARGET MOVEMENT POTENTIAL OF XTENDIMAX

## INTRODUCTION

EPA approved the registration for XtendiMax® With VaporGrip® Technology (XtendiMax; EPA Reg. No. 524-617) on November 9, 2016 for over-the-top of Dicamba-Tolerant soybean and cotton based on a range of scientific submissions provided to the agency over the preceding five years, including dozens of scientific studies and field trials assessing the potential for spray drift and volatility. The XtendiMax label was tailored to address that scientific review, with specific requirements to limit the potential for off-target movement, including an in-field buffer, wind speed restrictions, and spray nozzle requirements. EPA also made explicit in the registration that it would reevaluate the potential for off-target movement prior to approving any registration renewal before November 2018.

Since the November 2016 registration of XtendiMax, Monsanto has performed numerous additional studies and assessments, including five further field studies in locations across the U.S. and Australia, three additional studies modeling the possibility of volatilization, and one additional humidome study. In this effort, Monsanto has worked with EPA and university scientists, regarding the protocols for multiple of these field studies, and has performed other specific analyses requested by EPA. Indeed, field studies have been performed over crops planted in a broad range of geographies, temperatures and soil types with a range of pH levels that are highly representative of farming conditions in all U.S. states where cotton or soybean are grown.

To date, all of the post-registration field studies and modeling data confirms the scientific conclusions EPA reached in the 2016 XtendiMax registration, that under the XtendiMax label requirements: (1) vapor drift occurring due to volatilization should not result in impacts off the treated field; and (2) spray drift will not occur past the label's required buffer distances in amounts that would have an adverse effect on plant height.[1] This submission summarizes that body of hard scientific evidence.

In addition to all of these supplemental scientific analyses, Monsanto also addresses herein inquiries of off-target movement reported to Monsanto during the 2017 and 2018 seasons regarding alleged dicamba drift. Multiple new dicamba herbicides were applied in 2017 (Engenia®, XtendiMax, FeXapan™) for over-the-top use, while older higher volatility formulations that lack label restrictions intended to limit the potential for off-target movement remained in use in many locations for multiple purposes, including for use over corn (which is

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[1] U.S. EPA, *M1691 Herbicide, EPA Reg. No. 524-582 (Active Ingredient: Dicamba Diglycolamine Salt) and M1768 herbicide (Xtendimax), EPA Reg. No. 524-617 (AI: Diglycolamine Salt with VaporGrip™) – Review of EFED Actions and Recent Data Submissions Associated with Spray and Vapor Drift of the Proposed Section 3 New Uses on Dicamba-Tolerant Soybean and Cotton*, 5; *Second Addendum to the Environmental Fate and Ecological Risk Assessment for Dicamba DGA salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) for the Section 3 New Use on Dicamba-Tolerant Soybean* at 6.

naturally tolerant to dicamba) and on pastures. The scientific evidence does not support an assumption that the symptomology alleged in these reports is caused by the use of XtendiMax in accordance with label requirements. As a threshold matter, although 2017 saw an increase in reported complaints of alleged dicamba drift in specific locations and geographies, the frequency of complaints has dropped this year both in actual terms and in a per-million acres sprayed basis (as of July 19, 2018).[2] And the official 2017 soybean and cotton yield reports in the locations with the highest number of 2017 complaints generally *increased or even hit record yield levels. See infra* Section VIII or MRID 50639401 for a detailed summary of state and certain county specific reports. While a 2017 late season drought in multiple Northern Plains states impacted, soybean yield in those specific locations, a close evaluation of yield data across all states generally identifies *higher yield* in locations with *more of the alleged complaints*—and lower yield in locations with fewer complaints. In other words, there is no scientific basis to conclude that 2017 complaints regarding alleged dicamba off-target movement actually caused any wide-scale negative yield impacts. Indeed, 2017 yields in locations with the most concentrated uses of dicamba herbicides tended to increase. This evidence leads to two common sense conclusions: First, over-the-top use of dicamba provides tremendous value to American soy and cotton growers. Second, to evaluate any report of suspected "off-target movement" of dicamba, it is necessary to carefully verify all the relevant facts in order to support informed conclusions on an inquiry-by-inquiry basis. Throughout the 2018 growing season, Monsanto has taken exactly that approach, and has conducted several hundred field visits to evaluate any such reports it receives. Among other things, Monsanto has learned from these evaluations that grower training has been successful, and that any off-target movement of XtendiMax can be addressed through additional grower training.

In sum, the voluminous scientific evidence discussed herein:

- Confirms the conclusions regarding spray drift and volatility in EPA's 2016 risk assessment (and subsequent addendums) and registration decision.

- Demonstrates that there is no material difference in the volatility characteristics of XtendiMax across a wide range of soil types and pH levels, geographies, and temperatures, rebutting any hypotheses that such variations may cause volatility in quantities that will impact plant height outside of the treated field.

- Rebuts any hypothesis that off-target movement has caused widespread yield impacts by demonstrating that on a yield per acre basis, soybean and cotton yields were higher in 2017 than in any year other than 2016, and yields were higher than any other year in certain key states where complaints were reported to be highest—even in the face of complaints regarding alleged off-target movement (whether XtendiMax or not).

- Identifies a decrease in reported off-target movement inquiries in 2018, and identifies a series of conclusions Monsanto has reached from evaluating hundreds of reports of alleged off-target movement, confirming again that applications of

[2] In any event, the volume of inquiries is not a reliable indicator of whether "off-site incidents are occurring at unacceptable frequencies or levels."

XtendiMax in conformity with the label should not result in adverse effects. This decrease in inquiries reflects the positive impacts of the voluntary label amplifications made in 2017, including grower training.

## I. NEW FIELD FLUX DATA IS CONFIRMATORY OF FLUX DATA ANALYZED BY EPA IN 2016 REGISTRATION

Monsanto has conducted of a total of nine XtendiMax, M1691 and XtendiMax tank mix field studies conducted across a wide range of soybean and cotton fields (herbicide-tolerant traits, pre-/post-emergent), geographies, temperatures, humidities and soil types, of which six were previously submitted to EPA (Table 1). Site meteorological and flux monitoring meteorological data were recorded at each test site, and were used to calculate peak flux (volatility) rates using the aerodynamic flux and integrated horizontal flux methods.[3] The peak flux rates from studies conducted after the 2016 XtendiMax registration are consistent with and confirmatory of studies submitted prior to the registration. Monsanto then utilized only the *highest* peak flux rates from these calculation methods to model the potential for off-target movement due to volatility. Every modeled offsite dicamba air concentration was lower than both the NOAEC determined prior to the 2016 registration and the refined NOAEC that was later determined at EPA's request as described more fully below. In addition, for each of the field studies, Monsanto determined how much dicamba mass loss occurred relative to the amount of dicamba applied (percent mass loss); percent mass loss results for the studies conducted after the 2016 XtendiMax registration were consistent with those previously considered by EPA.

[3] For site meteorological data, seven environmental conditions were measured at, or within close proximity of, the test plots: (1) daily precipitation; (2) hourly soil moisture; (3) hourly air temperature at three different heights; (4) hourly soil temperature at three different depths; (5) hourly solar radiation; (6) minutely wind speed and direction at three different heights; and (7) minutely relative humidity. For flux monitoring meteorological data, a meteorological station near each plot measured three environmental conditions every minute and every hour at four different heights above the crop canopy: (1) air temperature; (2) wind speed; and (3) wind direction.

**Table 1:** Summary of Field Studies Conducted To-Date

| Remarks | Study Number | Year | State | Spray Area (acres) | Spray Mix | Study Duration (days) | Application Type | Volatility (Flux) | Drift | Plant Effects |
|---|---|---|---|---|---|---|---|---|---|---|
| Previously reviewed by EPA | WBE-2015-0221 | 2015 | GA | ~4 | Xtendimax | 3 | Pre-Emergent | X | | |
| | WBE-2015-0311 | 2015 | TX | ~10 | Xtendimax | 3 | Post-emergent DT-cotton | X | | |
| | WBE-2015-0220 | 2015 | GA | ~4 | M1691 Herbicide | 3 | Pre-Emergent | X | | |
| | WBE-2015-0312 | 2015 | TX | ~10 | M1691 Herbicide | 3 | Post-emergent DT-cotton | X | | |
| Previously submitted to EPA | STC-2016-0545 | 2016 | TX | ~4 | Xtendimax + PowerMax | 3 | Pre-Emergent | X | | |
| | | 2016 | TX | ~10 | Xtendimax + PowerMax | 3 | Post-emergent DT-cotton | X | | |
| | REG-2017-0646 | 2017 | NSW, Australia | ~37 | Xtendimax + PowerMax + Intact | 3 | Post-emergent RR-soybean | X | | |
| This Submission | STC-2018-0088 | 2018 | AZ | ~26 | Xtendimax + PowerMax + Intact | 3 | Post-emergent RR-soybean | X | X | X |
| | STC-2018-0084 | 2018 | MO | ~10 | Xtendimax + PowerMax + Intact | 5 | Post-emergent DT-soybean | X | | |
| | STC-2018-0091 | 2018 | NE | ~100 | Xtendimax + PowerMax + Intact | 3 | Post-emergent DT-soybean | X | | |

**A.** Volatility Field Studies Submitted Prior to the 2016 XtendiMax Registration

To evaluate the potential volatility of XtendiMax, EPA performed an independent assessment of four field volatility (flux) studies for XtendiMax and M1691 conducted in Georgia and Texas. U.S. EPA, *M-1691 Herbicide, EPA Reg. No. 524-582 (Active Ingredient: Dicamba Diglycolamine Salt) and M-1768 herbicide (Xtendimax), EPA Reg. No. 524-617 (AI: Diglycolamine Salt with VaporGrip™) – Review of EFED Actions and Recent Data Submissions Associated with Spray and Vapor Drift of the Proposed Section 3 New Uses on Dicamba-Tolerant Soybean and Cotton*, 5-12 (Nov. 3, 2016) [hereinafter M-1768 Review of EFED Actions]; *Final Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean* at 18. The field studies of XtendiMax and M1691 in Georgia and Texas tested real-world volatility potential under different application conditions and soil types. *M-1768 Review of EFED Actions*, Appx. at 6-7; MRIDs 49888501, 49888503, 49888401, 49888403. The soil type in the four-acre Georgia field study was a Tifton loamy sand with a soil pH of 5.6; the soil type in the 10-acre Texas field study was a Lake Charles clay with a pH of 6.0. The peak surface soil and air temperatures during the Georgia field study were 117°F and 89°F, respectively. The peak surface soil and air temperatures during the Texas field study were 155°F and 95°F, respectively. EPA concluded that the weather conditions in the Texas and Georgia field studies "made for near-idealized conditions for volatilization occurring after applications," thus approaching the worst-case scenario for volatility (flux). *M-1768 Review of EFED Actions* at 6. The highest peak flux values following XtendiMax and M1691 applications on a pre-emergent soybean field in Georgia were 0.0010 $\mu g/m^2/sec$ and 0.0069 $\mu g/m^2/sec$, respectively. The highest peak flux values following XtendiMax and M1691 applications on a post-emergent dicamba-tolerant cotton field in Texas were 0.0003 $\mu g/m^2/sec$ and 0.0007 $\mu g/m^2/sec$, respectively (Table 2).

**B.** New Volatility Field Studies Submitted Following the 2016 XtendiMax Registration

Since the initial registration in 2016, and for EPA's evaluation for the 2018 reregistration of XtendiMax, Monsanto has conducted a total of five additional volatility field studies. These particular studies utilized the XtendiMax tank mix that is used on 90% of all dicamba-tolerant soybean and cotton acres: XtendiMax (MON 76980) plus PowerMax (MON 79789, a glyphosate potassium salt) and a drift reduction agent.[4] These field studies not only confirm information provided prior to 2016, but also mimic many "real world" commercial applications and capture the full range of potential conditions that might cause volatility. These studies have been conducted in Texas, Australia, Arizona, Missouri and Nebraska. Final reports for the Texas (MRID 50578902) and Australia (MRID 50606801) studies have been previously submitted to EPA.

The field studies were designed to supplement prior scientific evaluations, and in particular to address the following questions:

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[4] A drift reduction agent such as Intact™ is required by the XtendiMax label for application of XtendiMax-glyphosate tank mixes and does not impact the volatility potential of XtendiMax.

1. Are the results of studies that EPA previously assessed representative of applications in a variety of other conditions and geographies?

2. Does volatility peak dramatically beyond three days after application?

3. Are studies conducted on small areas representative of large commercial-scale applications?

Like the field studies submitted in support of the 2016 XtendiMax registration, with the exception of the 2017 Australia study, these field studies were conducted in accordance with FIFRA's Good Laboratory Practice (GLP) Standards (40 C.F.R. § 160).[5] The study designs adhered to field volatility study guidelines as outlined in EPA's Fate, Transport and Transformation Test Guideline (2008). The measurement of dicamba from pre-application, application, and post-application was analyzed according to analytical method ME-1902.[6] Conducting these studies required significant man-hours and resources: for example, from field preparation to conclusion, the Arizona study alone required 22 trained personnel spending 696 total man-hours in the field. In designing the Australia and Arizona field studies, Monsanto coordinated testing protocol development with agricultural scientists at Purdue University, the University of Nebraska, and Mississippi State University, and, with regard to the Arizona field study, coordinated with and incorporated many specific recommendations from EPA.

**1.** Texas Volatility Field Study, MRID 5057892

In October 2016, Monsanto completed a GLP volatility field study using a XtendiMax and PowerMax tank mix in Fort Bend County, Texas, a key cotton-producing region. This study evaluated volatility over three days on two fields—one bare soil, pre-emergent field of approximately 4.6 acres (Bare Ground 1) and one post-emergent dicamba-tolerant cotton field of approximately 9.1 acres (OTT1). After application, samples from polyurethane foam (PUF) collectors were collected from five sampling heights above the soil/crop surface (0.15, 0.33, 0.55, 0.90, and 1.5 m) in the approximate center of each field at intervals of 6, 12, 24, 36, 48, 60, and 72 hours post-application. The highest peak flux rates for Bare Ground 1 and OTT1 were 0.003915 $\mu g/m^2/sec$ and 0.003032 $\mu g/m^2/sec$ respectively, which are consistent with peak flux values from

[5] The Australia field study discussed infra Section I.B.3 was not a GLP study, however there were quality control measures in place akin to the GLP standards to ensure the accuracy and validity of the study. Such measures included, for example, (1) selection of the location of individual plots within the larger field based on prevailing wind direction, not any specific agronomic characteristics; (2) analysis of data in accordance with accepted statistical methods; (3) confirmation that instruments used to measure meteorological conditions during application were used according to manufacture instructions; (4) monitoring by the study director of data collection and analysis; and (5) review by Monsanto Quality Assurance personnel of study documentation such as field notebooks and data contained therein.

[6] In addition, field exposed polyurethane foam (PUF) collectors were spiked with a known amount of dicamba for each field study site and weathered for approximately 6 and 12 hours to determine the amount, if any, of dicamba lost during sampling and to confirm the accuracy of on-field measurements.

the Texas and Georgia studies submitted prior to the 2016 XtendiMax registration (Table 2). This additional data demonstrates that the volatility potential of a relevant dicamba tank mix combination is consistent with the data previously assessed by EPA.

**2.** Arizona Volatility Field Study

In May 2018, Monsanto completed the field phase of a GLP field study on 26 acres of post-emergent glyphosate-tolerant soybean near Maricopa, Arizona. In designing the study protocol, Monsanto solicited feedback from EPA and incorporated study design recommendations from the Agency, including moving the location of the flux meteorology station, analyzing the tank mix samples for pH in the field and in the laboratory, placing additional upwind sample collectors, etc. Volatility was determined by analyzing air samples collected from (a) a single in-field air profile monitoring station with collectors at five heights (approximately 0.15, 0.33, 0.55, 0.9, and 1.5 m above crop height) located in the approximate center of the spray area, and (b) eight monitoring stations located around the perimeter of the sprayed application area with air monitoring collectors at 1.5 m above crop height. Samples from PUF collectors were taken approximately 6, 12, 24, 36, 48, 60, and 72 hours following application. The highest peak flux rate was 0.00044 $\mu g/m^2/sec$, which is consistent with peak flux values from the Texas and Georgia studies submitted prior to the 2016 XtendiMax registration (Table 2). This data demonstrates that the previously assessed studies on smaller acres are in fact representative of commercial applications that would take place on larger acres and that the extreme temperatures observed during the studies do not increase the maximum volatility measured.

**3.** Australia Volatility Field Study, MRID 50606801

In December 2017, Monsanto completed a spray drift and volatility field study in Walgett Shire, New South Wales, Australia, that mimicked the real-world commercial application of an XtendiMax tank mix over a larger number of acres during high temperatures. While not a traditional GLP study, there were robust data quality measures in place akin to the GLP standards to ensure accuracy, data quality and reconstructability (all of which are critical elements of the GLP standards). The study was conducted on glyphosate-tolerant soybean totaling approximately 37 acres which is representative of a commercial application. Air and soil surface temperatures during application reached 92.2°F and 113.7°F, respectively. Post-application, air temperatures reached approximately 105°F during each day of the study.

Flux was measured using an in-field air profile monitoring station located in the approximate center of each test plot spray area with sample collectors at five heights (0.15, 0.33, 0.55, 0.90, and 1.5 m above the crop surface). Samples were collected from PUFs at the five established sampling heights at intervals of 6, 12, 24, 36, 48, 60, and 72 hours post-application. The highest peak flux rate was 0.00109 $\mu g/m^2/sec$, which is consistent with peak flux values from the Texas and Georgia studies submitted prior to the 2016 XtendiMax registration (Table 2). This additional data again demonstrates that the studies previously assessed on smaller scale are representative of larger commercial applications and that extreme temperatures do not significantly increase the volatility potential of XtendiMax.

**4.** Missouri Volatility Field Study

In May and June 2018, Monsanto completed a GLP volatility field study in Scott County, Missouri, a key geographic region that reported incidents of alleged dicamba symptomology. This study evaluated volatility over an extended duration of five days on an approximately nine-acre field planted with dicamba-tolerant soybean. Prior to application, air samples were collected to determine the level of background dicamba within the application area and soil samples were collected and tested to determine soil pH and soil composition. Following a single application of the XtendiMax tank mix, volatility was measured for five days by analyzing air samples collected by 13 PUF collectors at approximately 6, 12, 24, 36, 48, 60, 72, 84, 96, 108, and 120 hours following application. Specifically, air samples were analyzed from (a) an in-field monitoring station in the approximate center of the spray area that collected air samples at five different heights, and (b) eight perimeter monitoring stations located approximately five meters from the edge of the sprayed area that collected samples at 1.5 meters above the tops of the plants. The highest peak flux rate was 0.00079 $\mu g/m^2/sec$, which is consistent with peak flux values from the Texas and Georgia studies submitted prior to the 2016 XtendiMax registration (Table 2). This data demonstrates that confirmatory flux is observed in a location that had a larger number of alleged drift complaints in 2017, that the maximum flux measured over five days is consistent with that measured over three days, and that extreme temperatures do not dramatically impact the volatility potential of XtendiMax.

**5.** Nebraska Volatility Field Study

In June and July 2018, Monsanto completed an approximately 100-acre GLP volatility field study in Seward County, Nebraska, a key geographic region that reported incidents of alleged dicamba symptomology. The field study was conducted over three days on an approximately 100 acre field with a 110-foot no-spray buffer around the plot. Following a single application of the XtendiMax tank mix, volatility was measured by analyzing air samples collected by 13 collectors at approximately 6, 12, 24, 36, 48, 60, and 72 hours following application. Specifically, air samples were analyzed from (a) an in-field monitoring station in the approximate center of the spray area that collected air samples at five different heights, and (b) eight perimeter monitoring stations located approximately five meters from the edge of the sprayed area that collected samples at 1.5 meters above the tops of the plants. The highest peak flux rate was 0.00183 $\mu g/m^2/sec$, which is consistent with peak flux values from the Texas and Georgia studies submitted prior to the 2016 XtendiMax registration (Table 2). Again, this data also confirms that the smaller-scale studies are representative of larger commercial applications, and that extreme temperatures do not dramatically impact the volatility potential of XtendiMax. Furthermore, the volatility results spraying over-the-top of DT-soybean and non-tolerant soybeans are consistent and confirmatory results.

**C.** Summary and Conclusions of Volatility Studies Submitted Before and After the 2016 Registration

Collectively, the submitted field studies capture a wide range of potential conditions that might arise in commercial applications of XtendiMax, including large application areas, extreme high temperatures, extreme high and low humidity, sandy soils, low or high soil pH levels and nighttime temperature inversions. These field studies targeted key states, geographies or climates that experienced reports of alleged dicamba symptomology in 2017, and in certain cases measure volatility for an extended period post-application to capture any possibility of volatility occurring during an extended time period.

**Table 2:** Summary of Conditions in which Field Studies have been Conducted To-Date

| Remarks | Year | State | Treatment | Timing | Flux ($\mu g/m^2$-s)[1] | Cumulative Mass Loss (%)[2] | Max. Soil Temp (°F)[3] | Max. Air Temp (°F)[4] | Off-Site Air Concentration ($ng/m^3$)[5] | Off-Site Dry Deposition ($g/m^2$)[6] | Soil Type | pH | Average Humidity (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EPA Reviewed Previously | 2015 | GA | XtendiMax with VaporGrip Technology + Induce | Pre-Emergent | 0.001 | 0.047 | 117 | 88 | 5.3 | 1.43E-06 | sand | 5.6 | 44.3 |
| | | TX | XtendiMax with VaporGrip Technology + Induce | Post-Emergent | 0.0003 | 0.063 | 155 | 96 | 2.4 | 9.93E-07 | clay | 6.0 | 49.9 |
| | | GA | M1691 Herbicide | Pre-Emergent | 0.004 | 0.078 | 117 | 89 | 13.4 | 3.47E-06 | loamy sand | 5.4 | 42.3 |
| | | TX | | Post-Emergent | 0.0007 | 0.122 | 155 | 95 | 7.7 | 2.12E-06 | clay | 5.5 | 46.4 |
| Previously Submitted to EPA | 2016 | TX | XtendiMax with VaporGrip Technology + Roundup Powermax Herbicide | Pre-Emergent | 0.0039 | 0.195 | 125 | 100 | 15.6 | 4.12E-06 | Clay loam | 5.5 | 75.6 |
| | | | | Post-Emergent | 0.0030 | 0.141 | 125 | 99 | 12.6 | 3.25E-06 | Clay | 6.8 | 75.7 |
| | 2017 | New South Wales, Australia | XtendiMax with VaporGrip Technology + Roundup Powermax Herbicide + Intact | Post-Emergent | 0.0011 | 0.077 | 133 | 108 | 4.35 | 1.50E-06 | clay loam | 8.2 | 37.0 |
| In This Submission | 2018 | AZ | XtendiMax with VaporGrip Technology + Roundup Powermax Herbicide + Intact | Post-Emergent | 0.00054* | 0.094* | 129 | 106 | 3.6 | 1.00E-06 | clay | 8.1 | 17.5 |
| | 2018 | MO | XtendiMax with VaporGrip Technology + Roundup Powermax Herbicide + Intact | Post-Emergent | 0.0008 | 0.204 | 135 | 95 | TBD | TBD | silt loam | 6.7 | 63.6 |
| | 2018 | NE | XtendiMax with VaporGrip Technology + Roundup Powermax Herbicide + Intact | Post-Emergent | 0.0018 | 0.146 | 127 | 91 | TBD | TBD | silt loam | 4.9 | 74.2 |

[1] Peak flux value from the 72-hour profile using AD and IHF methods, pre- and post- emergent plots

[2] Represents mass loss over duration of study; all studies were conducted over 3 days with exeption of MO study that was conducted over 5 days

[3] Surface soil temperature data from site meteorological station

[4] Based on data from flux meteorological station

[5] 95th percentile air concentration at 5 m from edge of field, 24 hr averaging, based on PERFUM modeling and all values are below the NOAEC of 138 $ng/m^3$ in MRID 50578901; Gavlick 2016

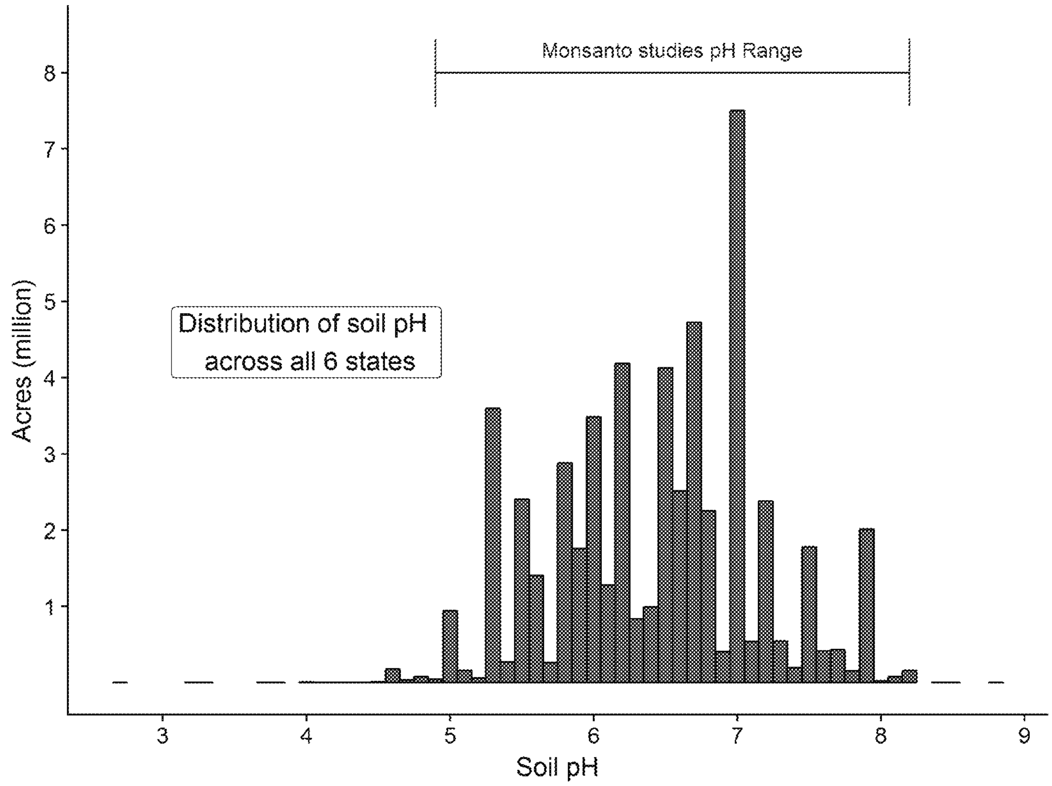
[6] 90th percentile dry deposition at 5 m from edge of field, 24 hr averaging, based on AERMOD modeling and all values well below the vegetative vigor endpoint NOAEC of 2.91E-05 $g/m^2$

* The indirect method produced the peak flux value and the mass loss for this study

The flux rates calculated across all eight field studies is consistent, and is characterized by a peak flux rate that is reached during the first 24 hours following application and low flux rates following the first 24-hour period, with slight diurnal variations (Table 2). The highest peak flux value was for M1691 in Georgia. The flux rates from studies submitted following the 2016 XtendiMax registration are comparable to those previously reviewed by EPA and equal to or below the maximum result for M1691 under a wide range of agronomically-relevant spray application scenarios.

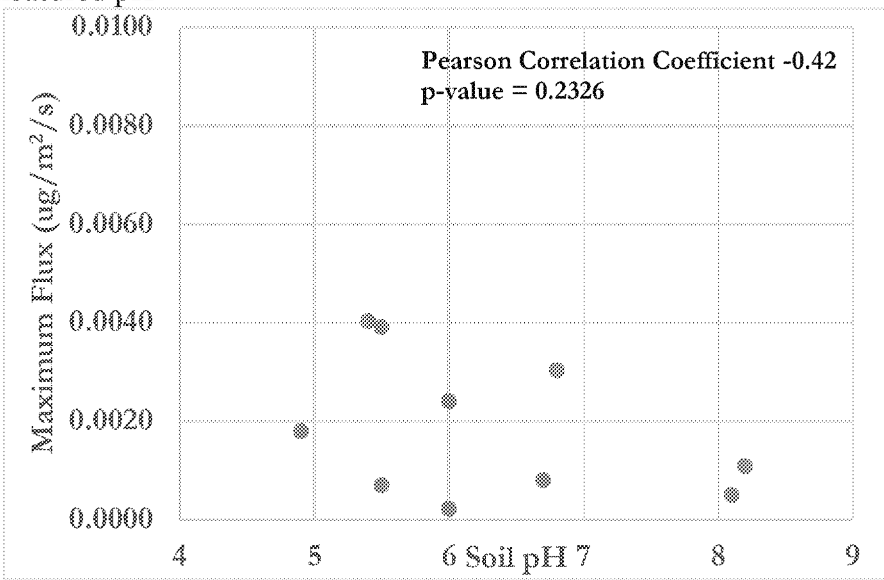
With regard to soil pH levels, the 2017 and 2018 field studies, together with prior field studies for XtendiMax and other dicamba formulations, capture the relevant range of soil pH levels on which soybeans are grown in the United States. In order to determine whether pH levels in the field studies are representative of soybean fields across the United States, Monsanto used the USDA SSURGO database to extract pH values for soil in any field on which soybeans were grown at any point between 2012 and 2016 in six key soybean-growing states—Arkansas, Georgia, Illinois, Missouri, North Dakota and Tennessee. This analysis shows that Monsanto's field studies have captured the pH levels of 99% of soybean fields (Figure 1).

**Figure 1:** Comparison of soil pH measured during field volatility studies and under soybean growing areas in six major soybean growing states




Critically, a comparison of the soil pH level from each field study and the estimated flux using the aerodynamic method shows no statistically significant correlation between soil pH and flux (p = 0.2326; Figure 2). In other words, even in particularly acidic soils, flux measurements fell within the same range as for applications over less acidic soil (compare flux measurements for soils with pH levels of 5 and 5.5 to soils with a pH level of 6.5).

**Figure 2:** Comparison of estimate aerodynamic flux during first six hours during field volatility studies with measured pH




Thus, volatility field studies conducted in 2016, 2017, 2018 and in prior years rebut any suggestion that the application of XtendiMax over particularly acidic soils (with pH levels between 5 and 6) can cause unanticipated volatility at levels greater than those previously determined in EPA's regulatory analyses. Of course, any contrary hypothesis would also be at odds with basic principles of chemistry, which have been addressed by chemist Dr. William Abraham. Specifically, VaporGrip® Technology in XtendiMax uses an acetic acid-acetate buffering system to scavenge any extraneous protons that could be brought into the system from the tank mixtures, or on the surface of foliage or soil as the spray droplets dry, thus significantly limiting the formation of volatile dicamba acid. XtendiMax is designed with the buffering capacity of VaporGrip® Technology to control potential changes in pH and prevent the formation of volatile dicamba acid. Considering most agricultural soils conducive to plant growth and development have a resulting pH well above any that would influence increased volatility of this technology, the buffering capacity of VaporGrip® Technology is adequate to resist any changes in the pH of the residue from the spray.

## II. MASS LOSS DATA FROM RECENT FIELD STUDIES FURTHER CONFIRMS PREVIOUSLY SUBMITTED STUDIES

For each field study, Monsanto calculated the mass of dicamba estimated to be volatilized during the duration of the study to understand the potential amount of dicamba that could be transported off-target. The calculated mass loss was consistent across all field studies described herein, regardless of geography, climate, or other application conditions and confirmed that only a small amount of dicamba is available to move off-target due to volatility, of which even a smaller amount could be in contact with non-target plants due to dispersive forces such as wind. These results further confirm EPA's previous risk assessment conclusions that volatility is a minor component of off-target movement and the downwind buffer will be protective of potential effects due to volatility.

**A.** Mass Loss Data Submitted Prior to the 2016 Registration Shows That Minor Amounts of Dicamba Volatilize Following Application

For the Texas and Georgia field studies using XtendiMax and M1691 submitted prior to the 2016 registration, mass losses were (1) 0.047% for the Georgia XtendiMax application (MRID 49888501), (2) 0.063% for the Texas XtendiMax (MRID 49888503), (3) 0.078% for the Georgia M1691 (MRID 49888401), and (4) 0.122% for the Texas M1691 application (MRID 49888403).

**B.** New Mass Loss Data is Consistent with Data Submitted Prior to the 2016 Registration

**1.** Texas Volatility Field Study, MRID 5057892

For the Texas field study submitted following the 2016 registration, total mass losses for the Bare Ground 1 plot was 0.195%. Total mass losses for the Cropped 1 plot was 0.141%. These mass loss calculations are consistent with mass losses in GLP field studies previously submitted to EPA.

**2.** Arizona Volatility Study

For the Arizona field study, total mass losses were 0.094%. These mass loss calculations are consistent with mass losses in GLP field studies previously submitted to EPA, thus showing that volatility does not increase over larger application areas and high heat conditions.

**3.** Australia Volatility Study, MRID 50606801

For the Australia field study, total mass losses were 0.077%. These mass loss calculations are consistent with mass losses in GLP field studies previously submitted to EPA, thus showing that volatility does not increase over larger application areas and high heat conditions. Further, these results show consistency in mass loss across various high heat field studies.

**4.** Missouri Volatility Study

For the Missouri field study, total mass losses were 0.204%. These mass loss calculations are consistent with mass losses in GLP field studies previously submitted to EPA, and show that mass loss does not increase significantly even over a measurement period of five days instead of three.

**5.** Nebraska Volatility Study

For the Nebraska field study, total mass losses were 0.146%. These mass loss calculations are consistent with mass losses in GLP field studies previously submitted to EPA, and show that mass loss does not increase significantly even over a larger application area (100 acres).

## III. THE REFINED NO OBSERVED ADVERSE EFFECT CONCENTRATION (NOAEC) PROVIDES AN ADDITIONAL MARGIN OF SAFETY

In early 2016, Monsanto submitted a dicamba vapor toxicity response humidome laboratory study that was used to determine a No Observed Adverse Effect Concentration (NOAEC). As described below, to address specific EPA comments, Monsanto has conducted an additional humidome study that determined a refined NOAEC. This refined NOAEC more precisely predicts the point at which exposure to dicamba will impact plant height, thereby providing an additional margin of safety in EPA's analysis of the results of air concentration modeling studies discussed in Section IV.

### A. NOAEC Calculated Prior to 2016 Registration (MRID 49925703)

In the first dicamba vapor toxicity response humidome laboratory study used to determine a NOAEC, soybean indicator plants and a dicamba-containing formulation were placed inside a closed dome for 24 hours. MRID 49925703. The closed dome was placed inside a growth chamber and the dicamba that was present inside the dome was measured. The soybean plants were then removed from the closed dome and placed in a greenhouse where they were rated for visual response 14 and 21 days after treatment (DAT) and plant height 21 DAT. In its 2016 risk assessment, EPA concurred with Monsanto's calculation that, based on this study, the maximum dicamba vapor air concentration that would not adversely affect non-target plants—known as the NOAEC—is 17.7 ng/$m^3$. *M-1768 Review of EFED Actions* at 5. EPA noted, however, that the dose spacing in the humidome study resulted in an approximately 30x difference between the NOAEC and the Lowest Observed Adverse Effect Concentration. *Id.* at 5. Thus, the NOAEC was overly conservative and *underestimated* the maximum dicamba vapor air concentration that would not adversely affect non-target plants. As such, EPA recommended an additional humidome study that examined a range of doses between the NOAEC and LOAEC to provide refined, more realistic NOAEC and LOAEC values. *Id.*

### B. Calculation of Refined NOAEC (MRID 50578901)

In response to EPA's comments, Monsanto conducted an additional humidome study in late 2016 that determined a refined NOAEC. MRID 50578901. This study used the same procedure as the previous humidome study, but used lower spacing between doses as shown below in Table 3.

**Table 3:** Measured vapor-phase dicamba concentrations in humidome and corresponding plant height measurements

| | | Dicamba Acid ng/PUF | | Dicamba Acid ng/m$^3$ | Plant Height (in) | | |
|---|---|---|---|---|---|---|---|
| Treatment Number | Spray Solution Composition (w/w) | Mean | Standard Deviation | Mean | Mean | Standard Deviation | Significant |
| 1 | Deionized water 6 Petri dishes | < 10 | ---- | < 3.5 | 28.08 | 1.18 | NA |
| 2 | 100% M1691 (1.2% ae) 6 Petri dishes | 89.9 | 29.9 | 31.2 | 28.75 | 1.31 | |
| 3 | 95% M1691 (1.2% ae) & 5% Banvel® (1.2% ae) 2 Petri dishes | 203 | 65 | 70.6 | 29.42 | 1.01 | |
| 4 | 95% M1691 (1.2% ae) & 5% Banvel® (1.2% ae) 4 Petri dishes | 344 | 97 | 120 | 29.00 | 2.13 | |
| 5 | 95% M1691 (1.2% ae) & 5% Banvel® (1.2% ae) 6 Petri dishes | 398 | 112 | 138 | 27.71 | 1.18 | |
| 6 | 75% M1691 (1.2% ae) & 5% Banvel® (1.2% ae) 2 Petri dishes | 684 | 127 | 238 | 24.63 | 1.11 | * |
| 7 | 75% M1691 (1.2% ae) & 5% Banvel® (1.2% ae) 4 Petri dishes | 1394 | 113 | 484 | 21.08 | 2.27 | * |
| 8 | 75% M1691 (1.2% ae) & 5% Banvel® (1.2% ae) 6 Petri dishes | 1546 | 638 | 537 | 19.88 | 0.87 | * |

No plant height effects to soybean plants were observed as a result of vapor-phase exposure to dicamba at concentrations of 138 ng/m$^3$ and below (Treatments 1 through 5). Therefore, the refined NOAEC was 138 ng/m$^3$, which should supplant the previous NOAEC used in EPA's 2016 risk assessment. This refined NOAEC adds an additional margin of safety to EPA's risk assessment, which evaluated air concentration and dicamba deposition as described below.

## IV. NEW DICAMBA AIR CONCENTRATION AND DEPOSITION MODELING IS CONFIRMATORY OF MODELING RESULTS ANALYZED BY EPA IN 2016 REGISTRATION

Monsanto has conducted a total of seven modeling studies using peak flux data from field studies to predict "upper-bound peak" or "worst-case" dicamba deposition and air concentration in three locations in key soybean or cotton-growing regions.[7] These studies used the Probabilistic Exposure and Risk model for FUMigants or PERFUM (air concentration) and the AERMOD (deposition) models, which have been adopted by EPA and are the Agency's preferred models for

[7] The locations modeled were Peoria, Illinois; Lubbock, Texas; and Raleigh, North Carolina. Multi-year meteorological files for each location were developed using standard EPA pre-processor programs and National Weather Service data sources.

such modeling. For the deposition analyses, AERMOD was used to estimate 24-hour average dicamba deposition for several downwind distances from the edge of the field following an 80-acre application of M1691, XtendiMax, or the XtendiMax + PowerMax tank mix. The deposition estimates represent high-end values that may occur in the direction the wind is blowing during meteorological conditions that are least conducive to gas dispersion. For the air concentration studies, PERFUM was used to estimate dicamba air concentration estimates for several downwind distances from the edge of the field following an 80-acre application of M1691, XtendiMax, or the XtendiMax + PowerMax tank mix. Additionally, air concentration estimates were made for four different averaging times, including 1, 4, 8, and 24 hours. As a conservative measure, these estimates represent the 95th percentile of the range of dicamba concentrations at each distance at different directions from the field based on the effects of the wind direction and variations in meteorological conditions. Thus, the air concentration estimates represent high-end values that may occur in the direction the wind is blowing during meteorological conditions that are least conducive to gas dispersion. The dicamba air concentration predicted by each AERMOD study are below both the NOAEC used by EPA in its 2016 risk assessment and the refined NOAEC later determined by Monsanto at EPA's request.

### **A.** Air Concentration and Deposition Modeling Submitted Prior to the 2016 XtendiMax Registration

As recommended by EPA, prior to the 2016 XtendiMax registration Monsanto used the peak flux data from the Texas and Georgia field studies to model upper-bound peak acid deposition and air concentration following XtendiMax applications in three locations. *M-1768 Review of EFED Actions* at 6; MRIDs 49925801 & 49925802. EPA compared these air concentration results to the NOAEC discussed in Section III.A. Based on that analysis, EPA determined that "the predicted upper bound peak air concentration values for the M-1768 formulation are essentially at or below the soybean vapor-phase NOAEC." *M-1768 Review of EFED Actions* at 6. EPA acknowledged certain uncertainties in its analyses, but concluded that "the amount of uncertainty in the exposure estimates is small enough that it is very unlikely that the exposure will exceed the effect threshold (NOAEC)." *Id.* at 7. Thus, EPA concluded, no buffer—other than already applicable for spray drift—was necessary to address any concerns regarding volatility. *M-1768 Review of EFED Actions* at 3.

### **B.** New Air Concentration and Deposition Modeling Submitted Following the 2016 Registration

In 2017 and 2018, Monsanto conducted new PERFUM and AERMOD modeling to supplement the modeling previously performed in 2015. The recent additional studies used the peak flux data from the post-registration Australia, Texas and Arizona XtendiMax tank mix field trials to calculate air concentration and deposition in the same three locations previously modeled (Raleigh, North Carolina; Lubbock, Texas; Peoria, Illinois). The results of the new deposition and air concentration modeling further demonstrate that, in a wide range of weather conditions and geographies, the commercial-scale application of XtendiMax will not result in air concentrations that will impact plant height outside the field.

**1.** Deposition and Air Concentration Modeling for a Spray Solution Containing MON 76980 Mixed with MON 79789 and Intact – Australia (MRID 50606802)

Using the flux rates determined by the Australia field study (MRID 50606801), Exponent modeled the air concentration and dry and wet deposition estimates of dicamba that could potentially occur downwind following application of the XtendiMax tank mix.

AERMOD deposition estimates: At 5 meters from the edge of the field, the maximum 24-hour average dry deposition ranged from $1.5\times10^{-6}$ to 2.8x10-6 g/$m^2$ and the maximum wet deposition ranged from $1.3\times10^{-7}$ to $2.5\times10^{-7}$ g/$m^2$. At the same distance, 5 meters from the edge of the field, the 90th percentile dry deposition ranged from $8.8\times10^{-7}$ to $1.5\times10^{-6}$ g/$m^2$, and the 90th percentile wet deposition ranged from $3.4\times10^{-9}$ to $1.4\times10^{-8}$ g/$m^2$. The results of the AERMOD modeling showed comparable deposition rates for Raleigh, Peoria and Lubbock, but that were slightly higher for Raleigh. As expected from general principles of air dispersion modeling, deposition declined with distance from the field.

24-hour PERFUM air concentration estimates 5 m downwind from edge of field: The estimated concentrations ranged from 2.9 to 4.4 ng/$m^3$. The Raleigh dataset produced highest air concentrations, and the concentrations declined with distance from the field. The concentrations also declined with higher averaging times because variability in wind directions results in concentrations declining over longer averaging times at a given location.

The results of the air concentration modeling are below both the NOAEC used in the 2016 registration and the refined NOAEC later determined at EPA's request. Thus, these new data further confirm EPA's conclusion in 2016 that no buffer is necessary to address any concerns regarding volatility.

**2.** Deposition and Air Concentration Modeling for Dicamba Formulation MON 76980 Mixed with Formulation MON 79789 – Texas (MRID 50578903)

Using the flux rates determined by the post-registration Texas field study (MRID 50578903), Exponent modeled the dicamba dry and wet deposition and air concentration estimates that could potentially occur downwind of an application of the XtendiMax tank mix.

AERMOD deposition estimates: For the fluxes from the bare ground at 5 meters from the edge of the field, the maximum 24-hour average dry deposition ranged from $4.45\times10^{-6}$ to $7.50\times10^{-6}$ g/$m^2$ and the maximum wet deposition ranged from $3.59\times10^{-7}$ to $8.45\times10^{-7}$ g/$m^2$. At the same distance, 5 meters from the edge of the field, the 90th percentile dry deposition ranged from $2.39\times10^{-6}$ to 4.12x10-6 g/$m^2$, and the 90th percentile wet deposition ranged from $6.80\times10^{-9}$ to $3.94\times10^{-8}$ g/$m^2$. For the fluxes from the cotton fields, at 5 meters from the edge of the field, the maximum 24-hour average dry deposition ranged from $3.53\times10^{-6}$ to $6.05\times10^{-6}$ g/$m^2$ and the maximum wet deposition ranged from $3.48\times10^{-7}$ to $7.28\times10^{-7}$ g/$m^2$. At the same distance, 5 meters from the edge of the field, the 90th percentile dry deposition ranged from $1.91\times10^{-6}$ to $3.25\times10^{-6}$ g/$m^2$, and the 90th percentile wet deposition ranged from $5.70\times10^{-9}$ to $2.62\times10^{-8}$ g/$m^2$. For meteorological sites, the highest concentrations were for Raleigh, North Carolina, and deposition declined with distance from the field.

24-hour PERFUM air concentration estimates 5 m downwind from edge of field: Estimated concentrations ranged from 10.0 to 15.6 ng/m$^3$ for the fluxes from the bare ground, and from 8.1 to 12.6 ng/m$^3$ for the fluxes from the cotton field. The Raleigh and Peoria meteorological datasets produced similar air concentrations, while the concentrations were lower in Lubbock. As expected, the concentrations declined with distance from the field.

The results of the air concentration modeling are below both the NOAEC used in the 2016 registration and the refined NOAEC later determined at EPA's request. Thus, these new data further confirm EPA's conclusion in 2016 that no buffer is necessary to address any concerns regarding volatility.

**3.** Deposition and Air Concentration Modeling for Dicamba Formulation MON 76980 Mixed with Formulation MON 79789 – Arizona

Using the flux rates determined from the Arizona field study, Exponent modeled the dicamba dry and wet deposition and air concentration estimates that could potentially occur downwind of an application of the XtendiMax tank mix.

AERMOD deposition estimates: At 5 meters from the edge of the field, the maximum 24-hour average dry deposition ranged from $1.1\times10^{-6}$ to $1.9\times10^{-6}$ g/m$^2$ and the maximum wet deposition ranged from $6.5\times10^{-8}$ to $1.5\times10^{-7}$ g/m$^2$. At the same distance, 5 meters from the edge of the field, the 90$^{th}$ percentile dry deposition ranged from $5.9\times10^{-7}$ to $1.0\times10^{-6}$ g/m$^2$, and the 90$^{th}$ percentile wet deposition ranged from $1.7\times10^{-9}$ to $9.2\times10^{-9}$ g/m$^2$. For meteorological sites, the highest deposition levels were comparable for all three sites, with the highest modeled deposition found at Peoria and Raleigh. Deposition declined with distance from the field.

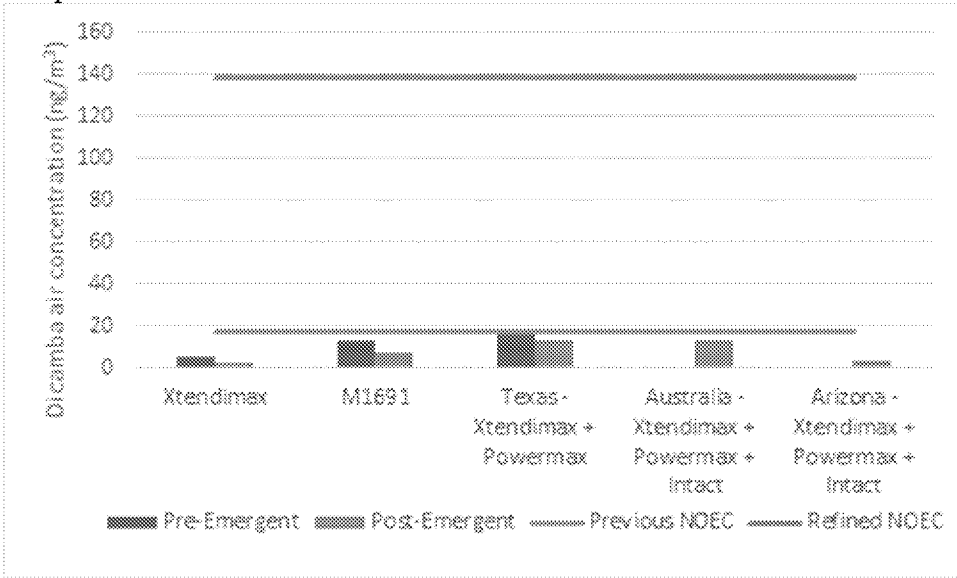
24-hour PERFUM air concentration estimates 5 m downwind from edge of field: Estimated concentrations ranged from 2.3 to 3.6 ng/m$^3$. The meteorological dataset for Raleigh produced the highest air concentrations. As expected, concentrations declined with distance from the field.

The results of the air concentration modeling are below both the NOAEC used in the 2016 registration and the refined NOAEC later determined at EPA's request. Thus, these new data further confirm EPA's conclusion in 2016 that no buffer is necessary to address any concerns regarding volatility.

**C.** Analysis of All Submitted Air Concentration and Deposition Modeling Results

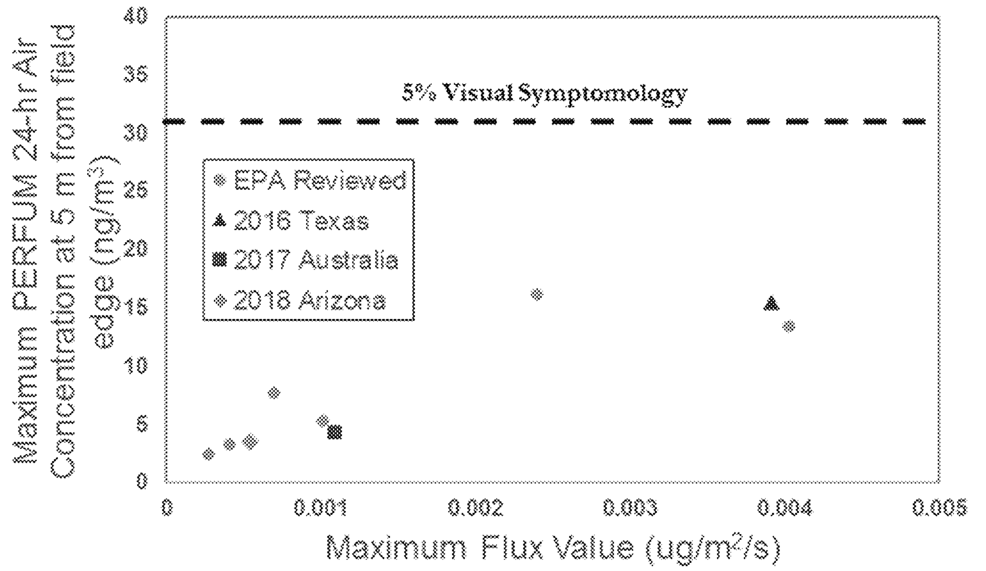
The results of all deposition and air concentration modeling conducted before and after the 2016 registration are below both the NOAEC used in the 2016 registration and the refined NOAEC determined at EPA's request in 2017 (Figure 3). Thus, volatility due to XtendiMax applications will not result in dicamba air concentrations that would have an adverse effect on plant height.

**Figure 3:** Comparison of PERFUM air concentration estimates to NOAEC and refined NOAEC




Although not considered an apical endpoint by EPA for use in risk assessment, symptomology of potential dicamba exposure to soybeans can be qualitatively evaluated using a visual rating system (e.g., Frans and Talber (1977), Behrens and Leuschen (1979) and Sciumbato et al. (2004)). In these rating systems, 5% symptomology corresponds to a slight crinkling of leaves and represents the lowest level of potential exposure that can be determined under field conditions. In order to understand the potential for exposure outside of the application areas, maximum off-target air concentrations that were modeled based on measured flux results from field studies were compared to the air concentration that resulted in 5% symptomology (31.2 ng/m$^3$) reported in Gavlick (2016). The dicamba air concentration modeling studies show that volatility due to M1691, XtendiMax and XtendiMax tank mix applications will not result in dicamba air concentrations that would cause 5% visual symptomology for any of the locations for which these data are available (Figure 4).

**Figure 4:** Comparison of PERFUM modeled air concentration estimates to 5% visual symptomology concentration

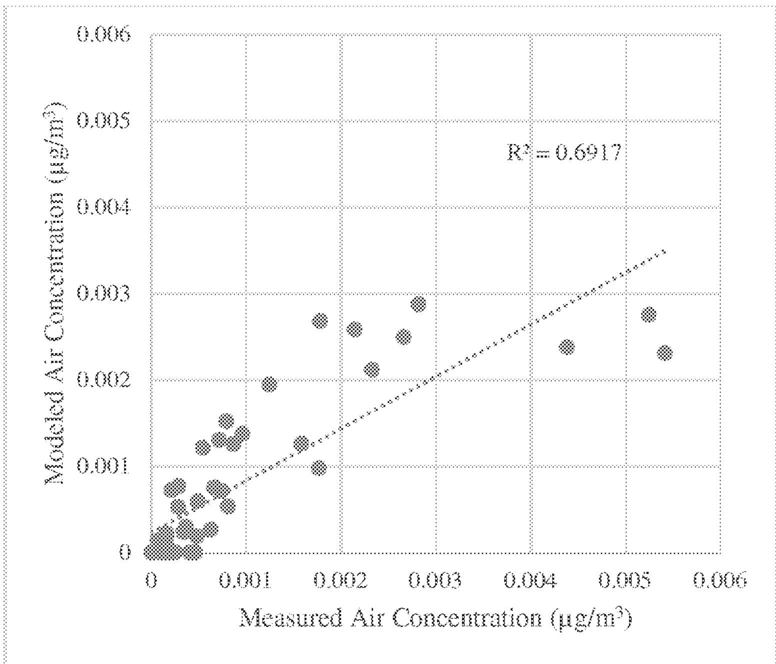



## V. MODEL VALIDATION CONFIRMS AIR DISPERSION MODELS ACCURATELY REPRESENT OFF-TARGET AIR CONCENTRATIONS

Both field studies and mathematical modeling tools have been used to evaluate pesticide losses due to off-target movement post volatilization. Modeling tools have the advantage of being able to be run over a long-time period to represent a wide range of environmental conditions under which applications can be made, thus allowing the assessment of the probability and risk of vapor transport to off-target areas. It is neither feasible nor practical to conduct the quantity of field studies over a range of conditions that can be modeled using established regulatory mathematical models. Furthermore, a risk-based approach for off-target assessment is sensible in a regulatory setting, where conservatism can be built at different levels to provide adequate margin of safety. For example, EPA PERFUM model in regulatory risk assessments.

In order to further confirm the utility of air-dispersion models such as PERFUM and AERMOD for use in regulatory risk assessment, and as part of a GLP field study conducted on 26 acres of post-emergent glyphosate-tolerant soybean near Maricopa, Arizona in May 2018, Monsanto collected additional meteorological information and conducted an expanded the off-field air sampling program to facilitate air dispersion modeling verification. The expanded off-field air sampling program included eight perimeter samplers placed at 5 m (16 ft) from field edge that continuously measured dicamba air concentration over each of the 6 sampling periods (totaling 63.6 hours after application). Dicamba air samples were also collected at the center of the field for the duration of study and was then used to calculate flux using EPA-recommended methods (i.e. aerodynamic and integrated horizontal flux). The aerodynamic flux was then used as input to the AERMOD model along with relevant meteorological data collected during the study. The predicted air concentrations were then compared to measured perimeter air concentrations outside of the field that were collected throughout the duration of the study to confirm suitability of air-dispersion models for dicamba off-target movement due to volatility[8]. The strong level of agreement between predicted and measured concentrations was determined using percent bias (PBIAS) model evaluation statistics. PBIAS measures the average tendency of predicted data to be larger or smaller that their measured counterparts. The results of the PBIAS evaluation indicated that the predicted concentrations are within 15% of their predicted counterparts (Figure 5). The predicted results show close agreement with measured concentrations, which confirmed that air dispersion models such as PERFUM and AERMOD are representative of potential off-target movement of dicamba following a representative commercial-scale spray application following label directions. Furthermore, the sound underpinnings for the models can be used probabilistically to conservatively estimate risk to provide adequate margin of safety.

**Figure 5:** Relationship between measured and predicted off-target air concentrations using location-specific flux and meteorological information




## VI. SPRAY DRIFT DATA

### A. Spray Drift Field Study Results Prior to the 2016 Registration

Drift exposure is "the principal risk issue" associated with the new uses of dicamba. *Final Registration of Dicamba on Dicamba-Tolerant Cotton and Soybean* at 17-18. In reaching its determination that a 110-ft. downwind, in-field buffer was necessary to protect off-target species from the effects of spray drift, EPA analyzed spray drift modeling, a spray drift droplet deposition

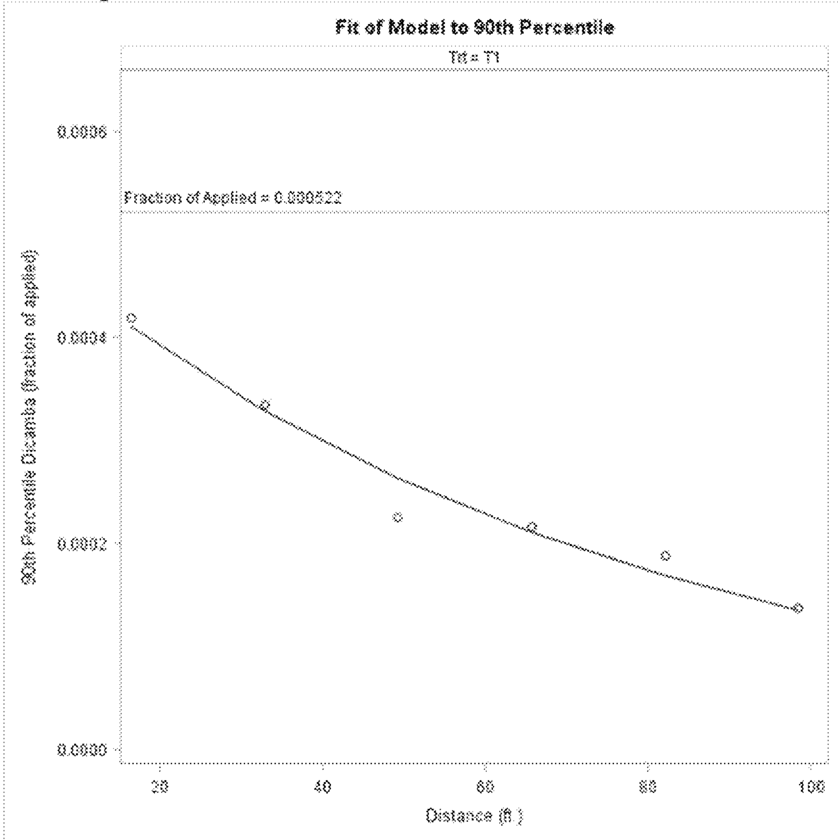
[8] It should be noted that this location-specific modeling was conducted in addition to the PERFUM and AERMOD modeling that was conducted using location-specific flux information and historical regional meteorological information that provides a robust probabilistic assessment of potential off-target movement due to volatility.

study, and multiple field trials each with multiple drift scenarios. EPA summarized those results in multiple record documents, including voluminous addenda. *Id.*; *M-1768 Review of EFED Actions*; U.S. EPA, *Dicamba DGA: Second Addendum to the Environmental Fate and Ecological Risk Assessment for Dicamba DGA salt and its Degradate, 3,6-dichlorosalicylic acid (DCSA) for the Section 3 New Use on Dicamba-Tolerant Soybean* at 2-6 (Mar. 24, 2016) [hereinafter Second Addendum]; U.S. EPA, *Addendum to the Environmental Fate and Ecological Risk Assessment for the Section 3 New Use of on Dicamba-Tolerant Soybean*, 4-8 (May 20, 2013) [hereinafter First Addendum]. Based on a weight of evidence approach and the results of spray drift modeling using the AgDRIFT model, EPA estimated the 90th percentile for the average distance of extra-course and ultra-course droplets from the field at 107 feet for a 0.5 lbs a.e./A application. Second Addendum at 2-4; First Addendum at 5-7. These results were further supported and confirmed by the result of eight spray field trials that were conducted under varying field conditions to represent a range of application scenarios. *Id.* at 7-8. In addition, a Texas field deposition study showed that dicamba would be present in amounts below the no-effect rate (NOER) at distances closer than 110 feet from the edge of the field; the corresponding distance in which the deposition was equivalent to the NOER (i.e., no-effect distance) was 77 ft. MRID 49770301. Accordingly, to prevent against the risk of effects from spray drift, EPA conservatively required a 110-foot downwind, in-field buffer when applying XtendiMax at the 0.5 lb a.e./A application rate, and a 220-foot buffer when applying at the 1.0 lb a.e./A application rate. First Addendum at 18.

**B.** Spray Drift Field Study Results Following the 2016 Registration

Following the 2016 registration, Monsanto conducted an additional spray drift field study in Arizona (which was in conjunction with the volatility field study discussed above in Section I.B.2). This field study evaluated spray drift by measuring the amount of dicamba that was deposited onto a total of 18 filter paper pads located along each of three transects, perpendicular to, and downwind of, the spray area at the following approximate distances: 5, 10, 15, 20, 25, 30 meters outside of the application area. Measured deposition rates downwind of the application area declined as distance from the application area increased and ranged from 0.000401 to 0.000132 on fraction of applied basis (Figure 6). No dicamba was detected in the upwind measurements.

**Figure 6:** Spray drift deposition was less than the no-effect rate for all downwind sample distances.



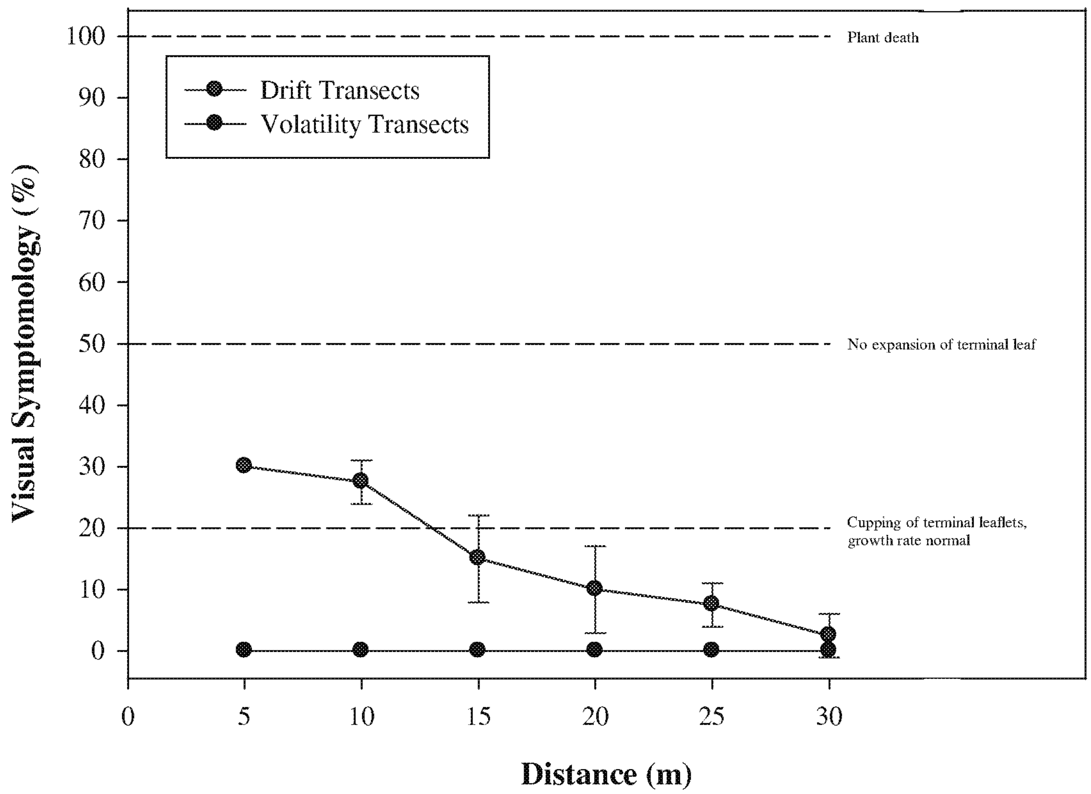

These results are consistent with and confirmatory of (1) EPA's 2016 determination that no spray drift would occur outside of the 110-ft. buffer area in amounts that could have an effect on plant height, (2) a Texas field deposition study that showed that dicamba would be present in amounts below the no-effect rate (NOER) at distances less than 110 feet from the edge of the field (MRID 49770301). These results also corroborate the plant effects results that were observed in the same field study and described in the following section.

## VII. PLANT EFFECTS DATA SHOWS THAT SPRAY DRIFT IS THE PRIMARY MEANS OF OFFSITE MOVEMENT

The Arizona spray drift and volatility field study also measured the relative contributions of spray drift and volatility on visual symptomology. Plant heights and visual symptomology were measured approximately 14 and 28 days post-application on ten plants at each distance along each transect (5, 10, 15, 20, 25, 30 m). Transect areas of approximately 30 m upwind and downwind of the application area were covered with tarps during application and for 30 minutes after application concluded in order to isolate the effects of volatility versus spray drift. Plants not covered by the tarps were exposed to dicamba caused by spray drift, whereas plants covered by the tarps were exposed to very little spray drift. Thus, by comparing visual symptomology and plant heights from both tarped and un-tarped areas of the field, Monsanto determined the relative contributions of volatility and spray drift to off-target movement. Visual symptomology was assessed on a scale of 0 to 100 with 0 representing no visible plant response and 100 representing complete plant death. This plant response rating scale was consistent with visual response ratings described in Frans and Talber (1977), Behrens and Leuschen (1979) and Sciumbato et al. (2004). In addition, cross-checks were implemented to ensure consistency across ratings.

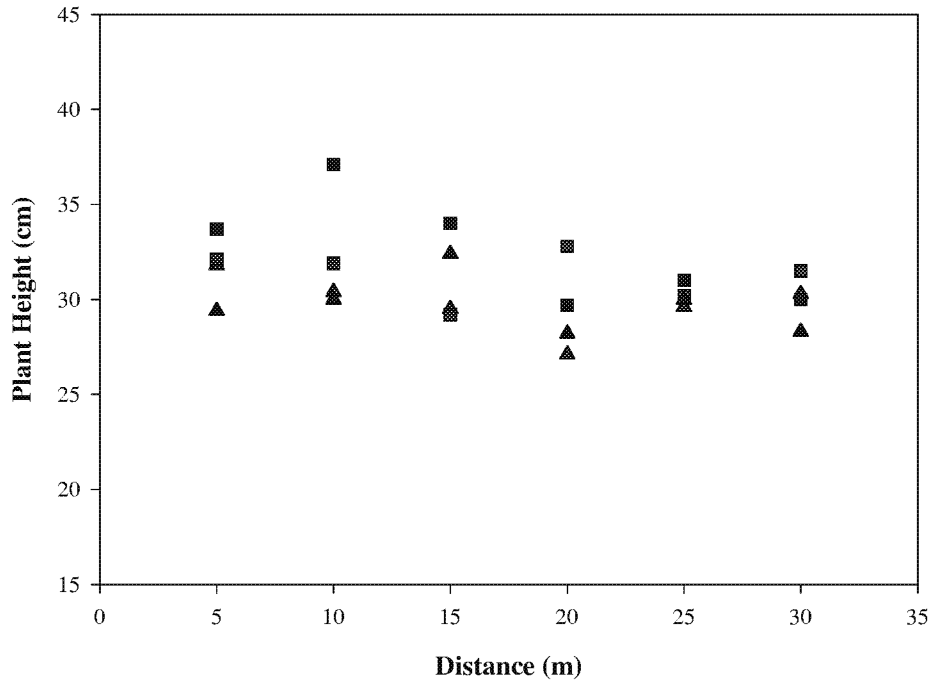
Downwind symptomology was observed for un-tarped dicamba-sensitive soybeans located downwind of the application area; this symptomology decreased as distance from the sprayed area increased. No symptomology was observed for plants that were located under the tarps during the spray application at 28 days after treatment (Figure 7).

**Figure 7:** Downwind symptomology results for drift (untarped) and volatility (tarped) transects




Although the results showed some downwind visual symptomology from spray drift inside the buffer distance, there was no statistically significant difference in plant heights for tarped and un-tarped soybean plants located downwind from the application area (Figure 8). Thus, although visual symptomology occurred within the buffer distance for soybeans exposed to spray drift, this symptomology was not sufficiently significant at any distance to result in reductions in plant height. This shows that spray drift levels were not high enough to reduce plant height, which is fully consistent with, and expected, given that the measurement of deposition were rates less than the NOER for plant height in all downwind locations. Indeed, a recent University of Missouri study indicates that visually identifiable symptomology below 40% does not generally signal a reduction in or impact to soybean yield.[9] Just as importantly, the upwind "volatility" transects showed no impact at all on plant height at any distance from the field.

**Figure 8:** Downwind plant height results for drift (untarped) and volatility (tarped) transects




These results further confirm that spray drift—not volatility—is the primary route of exposure for the off-target movement of dicamba.

[9] Moreover, five percent symptomology equates to slight crinkling in terminal leaves, but terminal bud growth is not inhibited and there therefore is no impact on yield. (Purdue University, 2017).

## IX. 2017 SOYBEAN AND COTTON YIELDS: NATIONWIDE AND IN PARTICULAR STATES

### A. Nationwide Production and Yield

On a nationwide basis, total U.S. production of soybeans and cotton hit record high levels in 2017[10]—notwithstanding a "punishing drought" that plagued the Northern Plains from May through the remainder of the year and "erratic rainfall" that depressed other Midwestern soybean yields.[11] Although increased soybean and cotton acreage in 2017 was one relevant factor in these record production totals, nationwide per acre soybean and cotton yields were also higher than those of any prior year in U.S. history, except for soybean per acre yields in 2016.[12] (The 2016 growing season saw more favorable Midwestern weather conditions, which contributed to the extraordinary yields that year.[13]) The success of 2017 soybean and cotton crops is reflected in USDA and other

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[10] Soybean production in 2017 totaled a record 4.39 billion bushels, and upland cotton production is estimated to be 21.3 million 480-pound bales, the highest totals reached by U.S. cotton growers in the prior decade and a 24 percent increase from the 2016 season. 2017 Crop Production Summary at 122-23; *see* USDA, National Agricultural Statistics Service, https://quickstats.nass.usda.gov/ (last visited July 25, 2018) (select Program: Survey; Sector: Crops; Group: Field Crops; Commodity: Cotton; Category: Production; Data Item: Cotton, Upland-Measured in 480 LB Bales; Domain: Total; Geographic Location: National; Time: 2018 through 2006; Period Type: Annual) (showing 2017 upland cotton production levels as highest in the prior ten years). Notably, two types of cotton are grown in the United States—upland cotton and pima cotton. Of that, 98.1% harvested is upland cotton. 2017 Crop Production Summary at 62.

[11] United States Department of Agriculture, National Agricultural Statistics Service, *Crop Production Summary* at 110 (Jan. 2018) http://usda.mannlib.cornell.edu/usda/current/CropProdSu/CropProdSu-01-12-2018.pdf ("2017 Crop Production Summary").

[12] *See* USDA, National Agricultural Statistics Service, https://quickstats.nass.usda.gov/ (last visited July 25, 2018) (select Program: Survey; Sector: Crops; Group: Field Crops; Commodity: Soybeans; Category: Yield; Data Item: Yield Measured in Bu/Acre; Domain: Total; Geographic Location: National; Time: 2018 through 1924; Period Type: Annual) (showing national soybean yield in 2017 as bested only by 2016 national year, which is the highest on record); *See* USDA, National Agricultural Statistics Service, https://quickstats.nass.usda.gov/ (last visited July 25, 2018) (select Program: Survey; Sector: Crops; Group: Field Crops; Commodity: Cotton; Category: Yield; Data Item: Cotton, Upland- Yield Measured in Lb/Acre; Domain: Total; Geographic Location: National; Time: 2018 through 1954; Period Type: Annual) (showing national cotton yield in 2017 (895 lb/acre) as highest on record).

[13] United States Department of Agriculture, National Agricultural Statistics Service, *Crop Production Summary* at 105 (Jan. 2017), http://usda.mannlib.cornell.edu/usda/nass/CropProdSu//2010s/2017/CropProdSu-01-12-2017.pdf ("In the Midwest, showery weather and the absence of extreme heat fueled record-high … soybean yield and production."). To be sure, comparing 2017 national soybean yields (49.1 bu/acre)

publicly available production/yield data and in public comments by national grower organizations, who in amicus briefs in pending litigation expressed the following views:

*Soybean Growers Association*:

- "With the benefit of Xtendimax, soybean growers set record production and crop yield levels during the 2017 growing season."
- "Soybean yields set records in nine states where Xtendimax was used."
- "With Xtendimax, soybean growers have demonstrated the ability to control glyphosate-resistant weeds and weed seed banks and set record production and yield levels on a record number of acres planted. Requiring soybean growers to battle glyphosate-resistant weeds without the critical benefit of Xtendimax is sure to diminish production and yield levels and reduce control over weed seed banks, in turn disrupting growers' contributions to the food supply and agricultural economy and reversing environmental benefits, not only in the immediate future but also for years to come."[14]

*National Cotton Council*:

- "[T]he importance of dicamba—a herbicide that historically has been registered for use on other crops, but which the development of herbicide-resistant cottonseed has rendered safe and cost-effective for use on cotton—cannot be overstated. While previous formulations of dicamba have been registered for many years, the EPA concluded that the new formulations registered for use on the dicamba herbicide-tolerant crops pose less risk than previous formulations."
- The EPA, in fact, reached the same conclusion that cotton growers across the country have reached based on their experience: Dicamba herbicides are an extremely effective tool whose potential harms can be safely cabined. Indeed, access to the dicamba chemistry in its improved formulations has

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against 2015 national soybean yields (48 bu/acre) is a more reliable comparison, where in 2015, Midwest farmers suffered from a "much more unfavorable rainfall distribution." United States Department of Agriculture, National Agricultural Statistics Service, *Crop Production Summary* at 84 (Jan. 2016), *available at* https://www.usda.gov/nass/PUBS/TODAYRPT/cropan16.pdf (further identifying that "torrential late-spring and early-summer downpours in the lower Midwest led to flooding and planting delays, following by a late-summer turn toward dryness that stressed poorly rooted corn and soybeans.").

[14] *See* Brief of Amici Curiae American Soybean Association and American Sugarbeet Growers Association, National Fam. Farm Coalition v. EPA, No. 17-70196 (E.C.F. 126-2).

become crucial to a grower's efforts to sustain weed control and effectively rotate MOAs ["modes of action"].[15]

**B.** Specific State and County Yield Data

Although certain litigants have contended that off target movement from multiple dicamba herbicides had widespread yield effects on soybean and cotton crops in specific locations where growers complained about dicamba applications, publicly available yield data demonstrates otherwise. Yields in Arkansas and Missouri provide two good examples. The two states received the highest number of grower dicamba complaints—by far—but also saw extremely positive soybean and cotton yields per acre.[16] Arkansas alone accounts for roughly 36% of all the nationwide complaints of alleged dicamba drift in the 2017 growing season.[17] But Arkansas also reported the highest yields per acre in the state's history in 2017.[18] Even more telling are the yields per acre reported from the specific counties in Arkansas where farmers reported the greatest number of alleged dicamba complaints. According to the Arkansas Plant Board, as of August 23, 2017, reports of alleged dicamba drift reached double- or triple-digits in ten counties in the state.[19]

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[15] *See* Brief of Amici Curiae National Cotton Council of America, National Fam. Farm Coalition v. EPA, No. 17-70196 (E.C.F. 118-2).

[16] For the purpose of cataloging the number of alleged complaints, we cite information compiled by Dr. Kevin Bradley of the University of Missouri, as his compilation purportedly collects the unverified reports made to all state agricultural agencies as well as information collected from university extension weed scientists. Bradley's "Final Report on Dicamba-Injured Soybean Acres" (October 30, 2017) may be accessed at https://ipm.missouri.edu/IPCM/2017/10/final_report_dicamba_injured_soybean/ (last visited July 25, 2018) ("Bradley Report"). Bradley indicates that in 2017, Arkansas growers made 986 complaints and Missouri growers made 310 complaints relating to alleged damage to soy acreage. To our knowledge, there are no estimates available from any source relating to alleged dicamba damage to cotton. We note, however, Dr. Bradley's acknowledgement that his "complaint" totals are unofficial "estimates" that do not reflect any conclusions of investigations by the state regarding whether the application of XtendiMax or of any other dicamba product was responsible for the purported damage nor the degree of any symptomology or potential yield impacts.

[17] *See* Bradley Report (Arkansas growers made 986 complaints, alleging 900,000 acres of damaged soybean from dicamba drift).

[18] *See* USDA, National Agricultural Statistics Service, https://quickstats.nass.usda.gov/ (last visited July 25, 2018) (select Program: Survey; Sector: Crops; Group: Field Crops; Commodity: Soybeans; Category: Yield; Data Item: Yield Measured in Bu/Acre; Domain: Total; Geographic Location: State; State: Arkansas; Time: 2018 through 1924; Period Type: Annual) (showing Arkansas' soybean yield in 2017 (51 bu/acre) as highest on record).

[19] Arkansas Dicamba Task Force Report at 26. During the 2017 growing season and for a few weeks thereafter, the Arkansas Plant Board posted online a map tracking complaints posted in various counties. The Plant Board has since taken down this map, but a screenshot of the map as of August 23, 2017 is available at the following website that indicates the same complaint numbers shown in the Arkansas Dicamba Task Force Report: Evan Allgood, ClassAction.com, "Dicamba

But in *every single one* of these ten counties, 2017 soybean yields increased from 2016 levels. Mississippi County—which alone accounted for 240 complaints of alleged dicamba drift—saw a 15.9% increase in soybean yields per acre from 2016 levels. Crittenden County (with 184 complaints) reported a 20.6% increase in yield per acre. Craighead County (92 complaints) experienced 8.9% increase. Poinsett County (89 complaints) saw a similar 8.2% increase. Soybean yields per acre increased by 11.7% in Saint Francis County (88 complaints) and Lee County (67 complaints) saw a similar increase at 11.5%. Phillips County (48 complaints) experienced an 8.2% increase; Cross County (45 complaints) a 7.1% increase; Monroe County (22 complaints) a 9.2% increase; and Clay County (15 complaints) a 17.1% increase.[20] These data show that there is no negative correlation between complaints reported and purported or actual decreases in yield per acre, as *every one* of the counties with the highest amounts of complaints within the *state* with the highest amounts of complaints experienced significant improvements in yield per acre.[21]

Missouri's 2017 soybean yield data is similar. Missouri's soybean production is concentrated in the southeastern portion of the state in an area known as the "boot heel." According to the Missouri Department of Agriculture, complaints of alleged dicamba damage in the 2017 growing season were concentrated in that region of the state, where there were at least 179 complaints.[22] But every one of the "boot heel" counties experienced marked increases in

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Complaints in Arkansas Approach 1,000 Mark", https://www.classaction.com/news/dicamba-complaints-arkansas/ (last visited July 25, 2018).

[20] *Compare* Arkansas Dicamba Task Force Report at 26 (indicating numbers of reports of purportedly dicamba-injured acreage in counties in Arkansas) *against* data available for yields in Arkansas counties from USDA, National Agricultural Statistics Service, https://quickstats.nass.usda.gov/ (last visited July 25, 2018) (select Program: Survey; Sector: Crops; Group: Field Crops; Commodity: Soybeans; Category: Yield; Data Item: Yield Measured in Bu/Acre; Domain: Total; Geographic Level: County; State: Arkansas; Counties: Mississippi, Crittenden, Craighead, Poinsett, Saint Francis, Lee, Cross, Monroe, Phillips, Clay; Select Time: 2016 and 2017; Period Type: Annual) (showing soybean yields grew between 2016 and 2017 for Mississippi, Crittenden, Craighead, Poinsett, Saint Francis, Lee, Cross, Monroe, Phillips, and Clay counties).

[21] For example, Mississippi County yields increased from 48.9 bu/acre (2016) to 56.7 bu/acre (2017); Crittenden County increased from 43.7 bu/acre (2016) to 52.7 bu/acre (2017); Cross County increased from 47.7 bu/acre (2016) to 51.1 bu/acre (2017); Lee County increased from 43.5 bu/acre (2016) to 48.5 bu/acre (2017); Monroe County increased from 43.2 bu/acre (2016) to 47.2 bu/acre (2017); and Phillips County increased from 48.9 bu/acre (2016) to 52.9 bu/acre (2017). *See* USDA, National Agricultural Statistics Service, https://quickstats.nass.usda.gov/ (last visited July 25, 2018) (select Program: Survey; Sector: Crops; Group: Field Crops; Commodity: Soybeans; Category: Yield; Data Item: Yield Measured in Bu/Acre; Domain: Total; Geographic Level: County; State: Arkansas; Counties: Mississippi, Crittenden, Cross, Lee, Monroe, Phillips; Select Time: 2016 and 2017; Period Type: Annual).

[22] *See* University of Missouri, Division of Plant Scientists, *Off-target Movement of Dicamba in Missouri. Where Do We Go From Here?* (August 21, 2017), *available at*

soybean yield per acre. Butler County (14 complaints) experienced a 23.8% increase in soybean yield per acre in 2017 as compared against 2016 yields. Dunklin County (21 complaints) experienced a 23.7% increase, and New Madrid County (25 complaints) saw a similar 24.9% improvement. Mississippi County (with the greatest among of complaints—50) experienced a 9.8% increase in soybean yield per acre. Pemiscot County (11 complaints) saw a 17.8% increase; Scott County (16 complaints) experienced an 8% increase, and Stoddard County (32 complaints) saw a 5.5% increase. The final county, Cape Girardeau (10 complaints), saw a 2.9% increase in yield per acre over 2016.[23] Arkansas and Missouri reported increases in state-wide cotton yield per acre as well.[24]

Tennessee provides another helpful example. Although reliable county-level information regarding complaints about purported dicamba drift has not been made publically available, USDA yield data confirms that Tennessee saw record yield per acre for soybean in 2017, despite 132 grower complaints about alleged dicamba off target movement.[25] Illinois is another interesting case. Despite the negative impacts of "erratic" weather in the 2017 growing season, the state's 2017 soybean yield data (59 bu/acre) is only negligibly smaller than the state's yields recorded in record year 2016 (59 bu/acre).[26] Illinois 2017 yields were greater than those of 2015, 2014, 2013—and all other prior years—despite numerous complaints of alleged dicamba drift in 2017.[27]

Of course, it was not just Arkansas, Missouri, Tennessee and Illinois that experienced successes in soybean and cotton yields in 2017 despite alleged dicamba drift complaints. Although

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https://ipm.missouri.edu/IPCM/2017/8/Off-target_movement/ (last visited July 25, 2017) (indicating numbers of reports of purportedly dicamba-injured soybeans in Missouri boot heel).

[23] *Compare, e.g.*, *id.* (indicating numbers of reports of purportedly dicamba-injured soybeans in Missouri boot heel) *against* data available at USDA, National Agricultural Statistics Service, https://quickstats.nass.usda.gov/ (last visited July 25, 2018) (select Program: Survey; Sector: Crops; Group: Field Crops; Commodity: Soybeans; Category: Yield; Data Item: Yield Measured in Bu/Acre; Domain: Total; Geographic Level: County; State: Missouri; Counties: Butler, Cape Girardeau, Dunklin, Mississippi, New Madrid, Pemiscot, Scott, Stoddard; Select Time: 2016 and 2017; Period Type: Annual) (showing each of the eight boot heel counties in Missouri experienced between a 2.8-24% increase in soybean yields over 2016). Technically, Bollinger County is part of the "boot heel" region as well. That county reported one alleged dicamba drift complaint, but we do not include it in this analysis because USDA does not have yield data available for this county.

[24] 2017 Crop Production Summary at 63.

[25] 2017 Crop Production Summary at 53.

[26] 2017 Crop Production Summary at 53, 100.

[27] *See* Bradley Report (Illinois growers purportedly making 245 complaints); USDA, National Agricultural Statistics Service, https://quickstats.nass.usda.gov/ (last visited July 25, 2018) (select Program: Survey; Sector: Crops; Group: Field Crops; Commodity: Soybeans; Category: Yield; Data Item: Yield Measured in Bu/Acre; Domain: Total; Geographic Location: State; State: Illinois; Time: 2018 through 1924; Period Type: Annual) (showing national soybean yield in 2017 as bested only by 2016 national year, which is the highest on record).

county level information is not publicly available, USDA state-level yield data further demonstrates the trend: farmers in Alabama, Mississippi, North Carolina and South Carolina all set new state records for soybean on a yield per acre basis in 2017.[28]

As noted, drought conditions suppressed yields in Northern plains states while other Midwestern states experienced other negative weather conditions.[29] Indeed, a large number of those states had relatively few complaints (compared to Arkansas, Missouri and Tennessee, for example), but felt significant impacts from weather and saw negative yield impacts.[30] For example, growers in Wisconsin reported only four alleged drift complaints but saw a nearly 15% drop in soybean yields, and Michigan farmers reported two complaints and suffered a 16% drop in yields.[31]

The appropriate conclusions from this data are plain: Complaints alleging dicamba off-target movement cannot be associated with any widespread yield losses on either soybeans or cotton. In fact, the available data suggests that the most profound yield gains occurred in several of the locations from which the highest numbers of complaints arose.

## X. ANALYSIS OF 2018 INQUIRIES

As EPA is aware, Monsanto voluntarily amplified the XtendiMax label following the 2017 growing season to further minimize the risk of applications that might move off-target in the 2018 growing season. Monsanto also voluntarily requested that EPA change the pesticide classification for XtendiMax, making it a restricted use pesticide for 2018. As a result of these changes:

- Xtendimax can be applied only by a certified applicator;
- XtendiMax applicators are subject to recordkeeping requirements that allow EPA and state regulators to better track when and where dicamba products were sprayed and under what conditions;
- XtendiMax applicators must complete dicamba-specific applicator training;
- XtendiMax can be applied only if maximum wind speed is between 3 and 10 miles per hour, reduced from a maximum of 15 miles per hour;

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[28] 2017 Crop Production Summary at 122-23.

[29] *Id.* at 110.

[30] 2017 Crop Production Summary at 110. *See also* Bradley Report (indicating complaints made in Illinois, Iowa, Kansas, Missouri, North and South Dakota, and Nebraska along with Wisconsin, Michigan, Ohio, Indiana and Minnesota)

[31] Bradley Report; Crop Production Summary at 53. Growers in Wisconsin and Michigan do not produce cotton of any type, either. *Id.* at 63.

- XtendiMax cannot be applied between sunset and sunrise, preventing applications when temperature inversions that exacerbate off-site movement are more likely to occur;

- XtendiMax applicators receive additional guidance about proper tank hygiene to prevent contamination; and

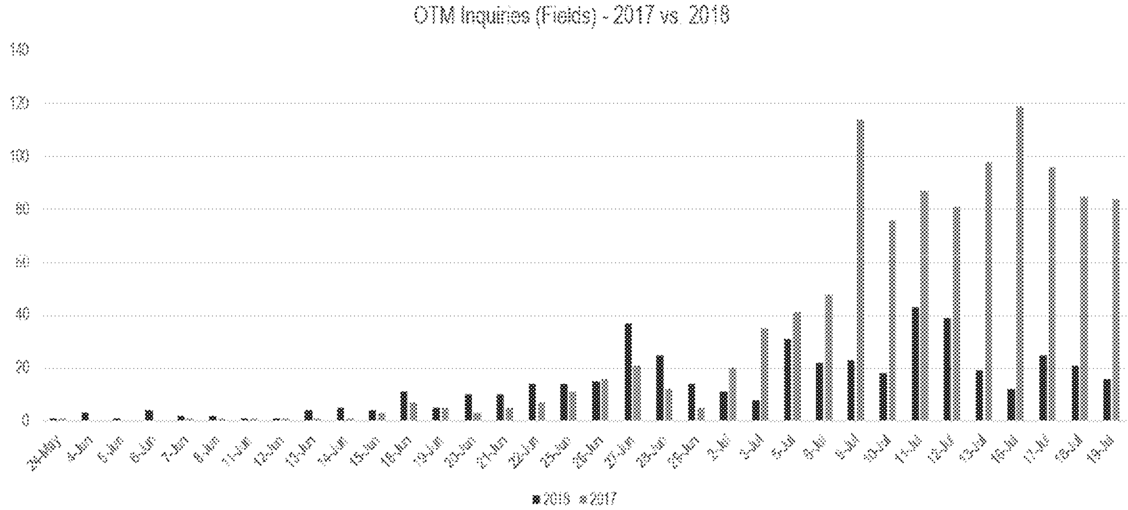
- XtendiMax applicators must identify and record the presence of sensitive crops near the application site to increase awareness of the risk to these crops.

As described, our efforts to evaluate hundreds of telephone calls regarding alleged off target movement demonstrated a range of specific circumstances, including neighboring dicamba applications over corn in many locations, issues with crops impacted by other non-dicamba herbicides, crops impacted by other phenomena such as disease or weather, applications that did not comply with required label conditions, and many circumstances where the crops at issue were not actually impacted, much less impacted by any herbicide application. As has become evident, *the number of complaints received does not necessarily correspond with any actual "injured" acreage associated with dicamba.* Indeed, we urge extreme caution in assuming any level of acreage injured simply based on the number of complaints identified. Without specific evaluations, any assumptions of what actually occurred on the field are not possible, and it is certainly not possible to equate the number of calls received with any allegedly harmed acreage totals. Any such assumptions would be unscientific.

Indeed, although we have completed 450 unique evaluations as of July 19, 2018, the number of acres allegedly associated with off-target dicamba movement—caused by a range of issues not implicating proper applications of XtendiMax—were only 14,345 acres

The available evidence shows that applicators have had greater success in avoiding applications that move off-target in 2018—likely due in part to the training by Monsanto of approximately 96,000 growers who apply XtendiMax. Indeed, as shown in the following charts, the number of inquiries made to Monsanto regarding possible off-target movement decreased dramatically in 2018 as compared to the same date in 2017 (468 as of July 19, 2018 as compared to 1002 on the same date in 2017), even as the total acreage of Xtend soybean and cotton nearly doubled:

**Figure 9:** Comparison of off-target movement inquiries – by date (2018 versus 2017)




This is in sharp contrast to the circumstances reported in the State of Arkansas, where XtendiMax was not approved for use in 2017 or 2018, where, according to the Arkansas Plant Board, the overall number of inquiries did not see as significant of a decrease. Because XtendiMax was not approved for use in the state of Arkansas, growers in that state did not have access to the same training as growers in other states. Moreover, growers in Arkansas who sprayed dicamba in 2018 would have done so unlawfully, and in most instances, likely would have utilized older, more volatile formulations of dicamba, which were offered for sale in the state and would not have had the benefit of lower volatility formulations, or the more protective XtendiMax labeling designed to minimize off-target movement.[32]

Importantly, as the analysis discussed below shows, the number of inquiries should not be construed as a valid measure of whether "offsite incidents are … occurring at unacceptable frequencies or levels." That said, because Monsanto has conducted a detailed and robust evaluation of each inquiry it has received, we have organized this analysis around those inquiries. Similarly, it is important to recognize that even where a field exhibits symptomology consistent with dicamba exposure, that symptomology by itself does not mean that there will be an impact on plant height or yield. In other words, symptomology by itself is not necessarily relevant to EPA's risk assessment, unless it is sufficient to impact plant height and yield.

Moreover, the overall number of acres allegedly impacted by off-site movement of dicamba has decreased dramatically in 2018 as compared to 2017. As shown in the table below, the number of inquiries have decreased from approximately 37 per million acres in 2017 to 8 inquiries per million acres in 2018. (Nor is there any evidence that the acreage allegedly affected per inquiry in 2018 is higher than in 2017.)

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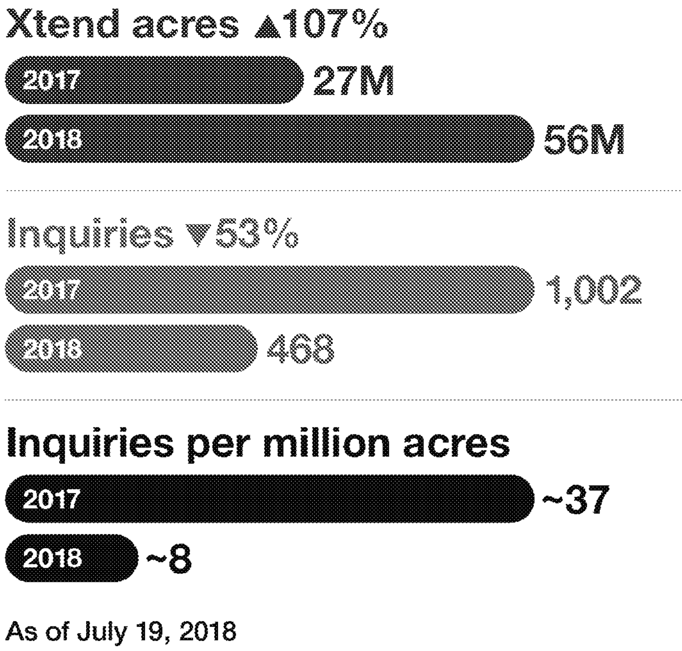
[32] Although Xtendimax was not sold in Arkansas in 2017 as well, in that year growers were able to apply BASF's Engenia product to Xtend crops. However, according to BASF, in 2017, BASF sold enough Engenia to spray only about half of the acres reportedly sprayed in the state, suggesting that rampant use of unregistered pesticides was a significant factor in 2017 as well.

**Figure 10:** Comparison off-target movement inquiries – by acres (2018 versus 2017)




At the same time, generic dicamba remains widely available – and widely used on corn, small grains and pasture land[33]– and lacks any of the significant formulation advances or label restrictions that are designed to minimize off-target movement. While it is not approved for in-crop applications to soybeans or cotton, the following are true for generic dicamba:

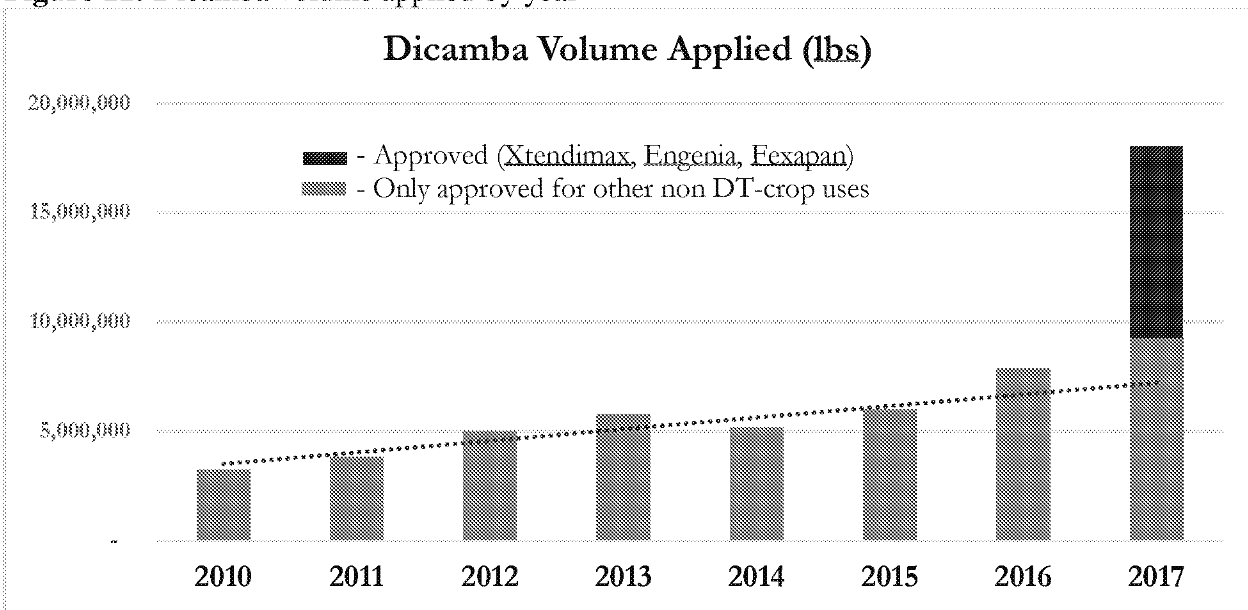
- Is not a restricted use pesticide and can be applied by anyone;
- Has no requirement for training to teach applicators how to minimize off-target movement before they can use the product;
- Is dramatically higher in volatility and in drift potential;
- Can be tank mixed with any product – including AMS – that may further increase drift and volatility potential;
- Need not be used with a drift reduction agent;
- Can be applied without any buffer to minimize downwind off-target movement;
- Can be applied using many nozzle-types rather than being restricted only to ultra-coarse nozzle types that minimize drift potential;

[33] Monocots such as corn are not affected by dicamba.

- Can be applied between sunset and sunrise, preventing when temperature inversions that exacerbate off-site movement are more likely to occur
- Can be applied aerially be applied during high wind events; and
- Are subject to absolutely no reporting and recordkeeping requirements.

Because generic dicamba is cheaper than Xtendimax, and approved for use in corn, many corn and small grain growers may prefer to use generic dicamba rather than Xtendimax (or any of the other new formulations). Because generic dicamba sales have increased significantly in recent years, applications of generic dicamba may be responsible for a portion of the reported incidents of off-target movement. There is increased usage of dicamba and dicamba containing pre-mix herbicides, for use in corn, small grains, and pastures, due to the effectiveness of the molecule in controlling resistant broadleaf biotypes (i.e. ALS, PPO, HPPD, PSII, glyphosate, and 2,4-D).

**Figure 11:** Dicamba volume applied by year




Building off of the lessons learned in the 2017 growing season, in 2018 Monsanto implemented an even more robust and rapid process for evaluating inquiries into off target movement, whether reported by herbicide applicators or by non-applicators. Monsanto's Field Engagement Specialists objectively evaluated every inquiry reported to us. Every inquiry call is answered within two business days, and every field or site allegedly affected is visited as soon as possible, with the goal three business days after return call is obtained. For incidents reported by non-applicators, the Field Engagement Specialists assess the allegedly-injured field to identify symptomology and impacted crops. All relevant facts are documented, including a precise measure of potentially impacted fields; expert panels, independent from the Field Engagement Specialists, review and evaluate all of the facts collected through this process. The data collected through this process is inputted and mapped in a database with a summary of conclusions obtained from the field inquiry.

As of July 19, 2018, Monsanto had received a total of 468 individual inquiries regarding off-target movement potentially related to dicamba. Of those, 172 were reported by applicators and 296 were reported by non-applicators. Review of 450 of those inquiries have been completed to date.

**Table 4:** Total inquiries evaluated by Monsanto (through July 19, 2018)

| Nature Of Inquiry | No of Inquiries | Contacted | Completed |
|---|---|---|---|
| OTM - Applicator | 172 | 170 | 163 |
| OTM - Non Applicator | 296 | 295 | 287 |
| **Grand Total** | **468** | **465** | **450** |

**Table 5:** Total inquiries evaluated by Monsanto – by state (through July 19, 2018)

| Field State | Applicator | Non-Applicator | Grand Total |
|---|---|---|---|
| **GA** | -- | 5 | 5 |
| **IA** | 41 | 20 | 61 |
| **IL** | 52 | 99 | 151 |
| **IN** | 16 | 13 | 29 |
| **KS** | 6 | 3 | 9 |
| **KY** | -- | 7 | 7 |
| **LA** | 1 | 8 | 9 |
| **MI** | 6 | 3 | 9 |
| **MN** | 4 | 10 | 14 |
| **MO** | 18 | 15 | 33 |
| **NC** | -- | 4 | 4 |
| **ND** | 1 | 39 | 40 |
| **NE** | 7 | 16 | 23 |
| **OH** | 4 | 10 | 14 |
| **OK** | -- | 2 | 2 |
| **SD** | 6 | 11 | 17 |
| **TN** | -- | 18 | 18 |
| **TX** | -- | 3 | 3 |
| **VA** | -- | 1 | 1 |
| **WI** | 1 | -- | 1 |
| **Total** | **163** | **287** | **450** |

This in-depth review resulted in several notable conclusions. ***First,*** of the 146 inquiries reported to have uniform symptomology, 60% were in Illinois. And virtually ***all*** of the impacted fields in Illinois had a higher density of corn, small grains, pasture and other fields surrounding the impacted soybeans than Xtend fields. Given the higher propensity of older dicamba formulations to drift and volatilize, coupled with the higher density of fields on which these dicamba formulations would have been used, the most likely conclusion is that the symptomology was the result of application of older dicamba formulations on those corn or small grain fields that bordered soybean fields. The remaining fields showing uniform symptomology were in a range of different states, but our analysis to date suggests that the same situation occurred in those other states as well. An example of such an inquiry evaluated by Monsanto is shown below (Map 1). The yellow shading shows where corn fields are located; blue represents Xtend soybeans, where Xtendimax may have been sprayed; red is the conventional soybeans that alleged an impact; and pink is LibertyLink soybeans.[34]

**Map 1:** Example Inquiry Investigated by Monsanto showing surrounding crop fields


As this illustration shows, it is far more likely that old dicamba sprayed on one of the adjacent corn fields was responsible for any alleged symptomology than Xtendimax sprayed on the Xtend field—particularly in light of the many label requirements on the Xtendimax label that are

[34] The red flag was Monsanto's point of entry and does not necessarily represent the location of any dicamba symptomology.

designed to prevent off-target movement, requirements which are not present on old dicamba and Group 4 labels used in corn, small grains, or other non-crop uses. This is one of multiple aerial images we can supply showing these circumstances.

The following table illustrates that corn was adjacent or near to potentially impacted fields far more often than were Xtend crops. And including other crops where old dicamba may be used (small grains, pasture, etc.), the numbers are even more disproportionate.

**Table 6:** Number of reported incidents where Group 4 herbicides may have been used in proximity to susceptible soybean fields (through July 19, 2018)

| | Proximity to OTM - Non-Applicator Inquiry Field | |
|---|---|---|
| **Landscape/Field*** | **50 Feet** | **100 Feet** |
| CORN | 611 | 819 |
| CORN STALKS | 2 | 2 |
| COTTON, XTENDFLEX | -- | 3 |
| SOYBEAN, XTEND** | 102 | 140 |
| SOYBEANS | 1 | 2 |
| PEANUTS | 1 | 2 |
| CRP | 10 | 14 |
| FALLOW | 2 | 2 |
| GOLF COURSE | 1 | 1 |
| HAY | 3 | 3 |
| GRASS/PASTURE/ETC | 89 | 112 |
| SORGHUM/SMALL GRAINS | 30 | 45 |

*Field reported may have contributed to inquiry field symptomology

**Includes unconfirmed but suspected Xtend soybeans fields

As noted above, application of these older higher volatility formulations over corn or small grains is allowed under those labels, but of course can result in visual symptomology to nearby soybean fields. These older dicamba formulations can be an order of magnitude or more volatile than Xtendimax, but no buffer is required nor are there any restrictions on application during inversions or periods of high wind, nor any requirements to use ultra-coarse nozzles to minimize drift or any restrictions on using tank mixtures that could increase drift and volatility.

It is reasonable to consider why such incidents would be appearing for the first time now, when old dicamba has been on the market for use on corn, small grains and pasture for decades. But it is important to recognize that Xtendimax has been the subject of unprecedented publicity and scrutiny. That scrutiny resulted in several positive outcomes, including: a significant drive to improve label compliance; unprecedented efforts to reduce pesticide drift; unprecedented grower training; and unprecedented recordkeeping to facilitate compliance and enforcement. But that scrutiny also appears to have resulted in growers noticing – and reporting for the first time – effects that likely have been present for years as a result of off-target movement of other pesticides, old dicamba, and agronomic stress.

***Second,*** and relatedly, in many instances (approximately 6 percent), Monsanto's in-depth inquiry revealed that no Xtend field was located near to the alleged incident. Again, however, other potential sources (including corn and small grains, where old dicamba can be sprayed) were located close to the field. An illustration of one such actual field is shown below (Map 2). (Yellow shading shows where corn fields are located; green represents trees and grass; red is LibertyLink soybeans; and purple is the LibertyLink soybeans that alleged an impact.)

**Map 2:** Example Inquiry Investigated by Monsanto showing surrounding crop fields


As noted above, it is likely that this type of visual symptomology had been occurring for years but was not widely recognized until the recent scrutiny of Xtendimax.

***Third,*** the label enhancements and the training conducted in 2018 have had notable success in helping applicators reduce off-target movement. For example, only ***eight*** applicators inadvertently mixed AMS in the tank in 2018—a dramatic improvement from 2017. And overall, the incidences of non-compliance with the label were small—and substantially fewer than in 2017. Nonetheless, label non-compliance was responsible for approximately 66 percent of the incidents evaluated by Monsanto to date. The table below shows the types of applicator errors that have been identified in our investigations. (Note that more than one error could have been reported in a single incident.)

**Table 7:** Results of inquiries evaluated by Monsanto – applicator label compliance (through July 19, 2018)

| Application Requirements (Applicator Reported) | Compliant | Not Compliant | Information Not Provided |
|---|---|---|---|
| **Use of Required Buffer** | 81 | 80 | 2 |
| **Tank Mix** | 115 | 45 | 2 |
| **Approved Nozzle** | 148 | 11 | 3 |
| **Boom Height @ Application** | 145 | 12 | 6 |
| **Wind Speed** | 153 | 0 | 10 |
| **Equipment Speed** | 51 | 0 | 1 |

***Fourth,*** a detailed review of the symptomology demonstrated, from non-applicator fields, that in 13 percent of cases, dicamba could not have been the cause of the alleged incident. For example, in some cases the symptomology was consistent with 2,4-D exposure.

**Table 8:** Results of inquiries evaluated by Monsanto of non-dicamba symptomology (through July 19, 2018)

| Symptomology | Inquiry |
|---|---|
| **2,4-D** | **19** |
| **Agronomic/Disease/Stress** | **16** |
| **Other Group 15** | **20** |

***Fifth,*** system hygiene/contamination improved dramatically this year as a result of the increased training and the label enhancements, but remained the cause of approximately 5 percent of the reported incidents. For example, Monsanto has identified incidents where a tank mixture was refilled in-field from the supplier, and symptomology was exhibited uniformly across the field, but was identified where the sprayer skipped areas around the field edge. This area initiated further conversation with supplier and grower to determine hygiene issues with the bulk load(s).

***Sixth,*** the overall number of acres with potential symptomology is low – only 14,345 acres as of July 19. Monsanto notes here that its detailed, site-specific evaluations provide the best evidence of actual acres potentially impacted. Although AAPCO has been tracking reported incidents by state, not all states are participating – and those states that do participate may report number of individual incidents but not the acres potentially impacted. And while Dr. Kevin Bradley has suggested larger numbers of potentially impacted acres by state, Dr. Bradley's estimates are admittedly anecdotal and do not identify any yield impacts – and in any event are generally not consistent with what those states have reported via AAPCO.

***Seventh,*** Xtendimax volatility caused few ***if any*** incidents of off-target movement. Indeed, Monsanto has identified only eight incidents (less than 1%) where volatility even possibly could have been the cause – and none of those were confirmed to be caused by volatility as all eight incidents had other potential causes as well. The areas are limited to defined gradient from source field directly adjacent and could be a result of variable winds, sprayer velocity at head row, and/or boom height during turnaround. In none of these cases was uniform symptomology observed; all areas exhibiting symptomology we confined to near the field edge adjacent to source field. Moreover, any off-target movement of XtendiMax can be addressed effectively through additional grower training. In sum, the number of off-target movement inquiries reported to Monsanto has decreased in 2018 even as the number of dicamba-tolerant soybean acres planted doubled. And the number of reports of suspected off-target movement per acre of dicamba-tolerant soybean planted has declined **by 54%** from 2017 to 2018. Moreover, as in 2017, the state with the highest number of complaints of off-target dicamba damage in 2018 is Arkansas, where Xtendimax is not sold. Finally, it is important to recognize that even where a field exhibits symptomology consistent with dicamba exposure, that symptomology by itself does not mean that there will be an impact on yield. Indeed, as discussed above, 2017 saw record yields in much of the country – and particularly in areas that saw the highest numbers of dicamba-related complaints. Monsanto would be happy to provide EPA with more detail about the 2018 incident database, if requested.

Finally, it is important to note the tremendous benefits of XtendiMax, which is a key consideration in EPA's registration decision. In 2017, 97% of growers surveyed who applied XtendiMax were satisfied with weed control. (August 2017 survey of growers using XtendiMax). Moreover, in 2015 and 2016 Monsanto herbicide system trials, comparing the performance of the Xtend crop system to other competing weed control systems, the use of XtendiMax with Roundup Ready® Xtend soybeans yielded a 5.4 bushel per acre advantage over the leading alternative herbicide system.

**Photograph 1:** 2,4-D leaf strapping symptomology on cotton

**Photograph 2:** Iron Chlorosis exhibited on young soybeans

**Photograph 3:** Disease exhibited on Green Peas

**Photograph 4:** Leaf puckering and drawstring affect from chloroacetamide application in soybeans